Enclosure 7

International Meetings

MG16 5-10 JULY 2021

SIXTEENTH MARCEL GROSSMANN MEETING

ON RECENT DEVELOPMENTS IN THEORETICAL AND EXPERIMENTAL GENERAL RELATIVITY, ASTROPHYSICS AND RELATIVISTIC FIELD THEORIES

CELEBRATING THE 50TH ANNIVERSARY OF "INTRODUCING THE BLACK HOLE" AND THE BLACK HOLE MASS ENERGY FORMULA

VIRTUAL MEETING

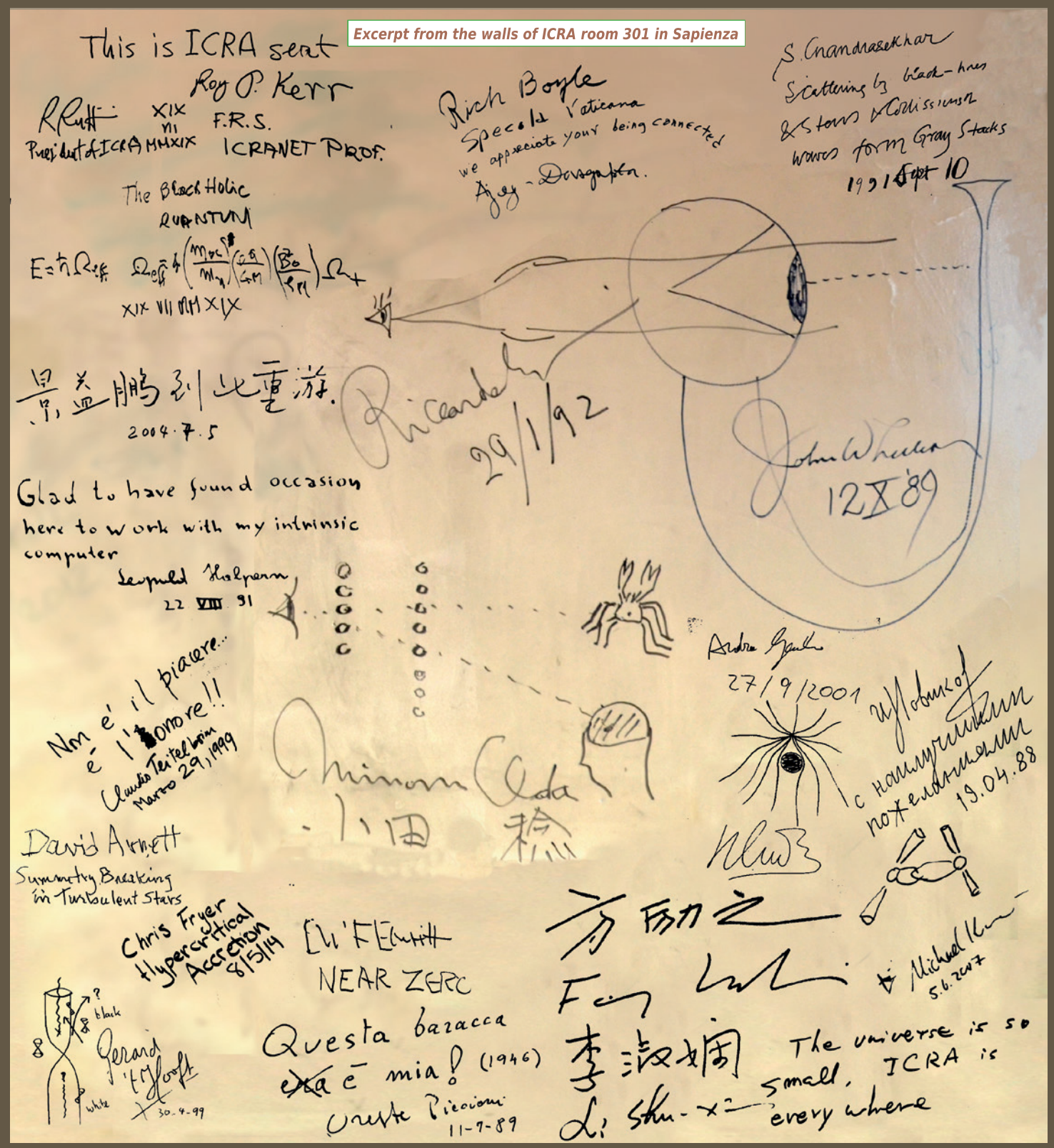
websites:
http://www.icra.it/mg/mg16/
https://indico.icranet.org/event/1/

email:
mg16@icranet.org

6:30-19:30 CENTRAL EUROPEAN SUMMER TIME

INTERNATIONAL COORDINATING COMMITTEE

ALBANIA: Hafizi M. - **ARGENTINA**: Arguelles C., Scoccola C., Reula O., Romero G.E. - **ARMENIA**: Sahakyan N. - **AUSTRALIA**: Blair D., Ju L., Lun A., Manchester D., Melatos A., Quinn P., Scott S.M., Steele J.D. - **AUSTRIA**: Aichelburg P.C., Schindler S. - **BELARUS**: Kilin S., Prakapenia M., Siutsou I. - **BELGIUM**: Henneaux M. - **BOLIVIA**: Aguirre C.B. - **BOSNIA**: Pasic V. - **BRAZIL**: Barres de Almeida U., Coelho Goulart J., Dalmolin F.T., de Lima Rafael C.R., Guzzo M., Maia C., Malheiro M., Romero Filho C.A., Shellard R.C., Zen Vasconcellos C. - **BULGARIA**: Yazadjiev S. - **CANADA**: Singh D., Smolin L., Turok N. - **CHILE**: Bauer F., Bunster W.C., Giacomini A. - **CHINA (MAINLAND)**: Cai R., Cai Y., Cao Z., Chang J., Chen J., Chen X., Dai Z., Feng L.-L., Han W., Jing Y., Li T.-P., Lin W., Lou Y.-Q., Luo J., Mei J., Tam T., Wang A., Wang Y., Wu X.-P., Wu Y.-L., Yuan Y.-F., Zhang B.-B., Zhang S.-N., Zhao G. - **CHINA (TAIWAN)**: Chen Chiang-Mei, Chen Pisin, Lee Da-Shin, Lee Wo-Lung, Ni Wei-Tou - **COLOMBIA**: Bargueño de Retes P., Gonzalez G., Higuera Garzon M.A., Núñez L., Romano A.E, Valenzuela Toledo C.A., Zuluaga J.I. - **CROATIA**: Dominis Prester D., Karlica M., Milekovic M., Smolcic V., Smolic I., Suric T. - **CUBA**: Perez Martinez A., Pérez Rojas H. - **CZECH REPUBLIC**: Bicak J., Stuchlik Z. - **DENMARK**: Naselsky P. - **ECUADOR**: Contreras E. - **EGYPT**: Tawfik A.N., Wanas M.I. - **ESTONIA**: Einasto J., Saar E. - **FINLAND**: Poutanen J., Volovik G. - **FRANCE**: Brillet A., Buchert T., Chardonnet P., Coullet P., de Freitas Pacheco J.A., Deruelle N., Iliopoulos J., Lamanna G., Mignard F. - **GEORGIA**: Lavrelashvili George, Machabeli Giorgi - **GERMANY**: Biermann P., Blumlein J., Di Piazza A., Fritzsch H., Genzel R., Gilmozzi R., Hasinger G., Hehl F., Keitel C., Kiefer C., Mirzoyan R., Neugebauer G., Nicolai H., Renn J., Ringwald A., Ruediger A. - **GREECE**: Batakis N.A., Cotsakis S., Vagenas E.C. - **HUNGARY**: Fodor G., Levai P. - **ICELAND**: Bjornsson G., Jakobsson P. - **INDIA**: Chakrabarti S.K., Iyer B., Padmanabhan T., Souradeep T. - **IRAN**: Baghram S., Bavarsad E., Eslam Panah B., Firouzjahi H., Haghighat M., Mansouri R., Mashhoon B., Shakeri S., Sobouti Y., Taghi Mirtorabi M. - **IRELAND**: O'Murchada N. - **ISRAEL**: Milgrom M., Nakar E., Pe'er A., Piran T. - **ITALY**: Belinski V., Bianchi M., Bianco C.L., Cherubini C., Della Valle M., Falciano S., Filippi S., Haardt F., Menotti P., Merafina M., Pani P., Ricci F., Treves A., Vereshchagin G.V., Vitale S., Xue S.-S. - **JAPAN**: Fujimoto M.-K., Makishima K., Nakamura T., Sato K., Shibata M. - **KAZAKHSTAN**: Abishev M., Aimuratov Y., Boshkayev K., Mychelkin E.G., Spitaleri C. - **KOREA (PYEONGYANG)**: Kim J.S. - **KOREA (SEOUL)**: Kim S.P., Kim S.-W., Lee H.K., Lee H.-W., van Putten M. - **KYRGYZSTAN**: Gurovich V.Ts. - **LIBYA**: Gadri M. - **MEXICO**: Breton N., Cervantes-Cota J.-L., Fraija Cabrera N.I., García-Diaz A.A., Macías Alvarez A., Mielke Eckehard W., Quevedo H., Rodriguez L.F. - **NETHERLANDS**: Slagter R. - **NEW ZEALAND**: Visser M., Wiltshire D. - **NORWAY**: Elgaroy O., Fonseca Mota D., Knutsen H. - **PAKISTAN**: Qadir A., Qamar S. - **PERU**: Vargas T. - **POLAND**: Belczynski K., Demianski M., Lewandowski Jerzy, Nurowski P., Sokolowski L. - **PORTUGAL**: Costa M., Da Silva A., Lemos J.P.S., Lobo F., Moniz P., Silva L.O. - **ROMANIA**: Visinescu M. - **RUSSIA**: Aksenov A., Arkhangelskaja I., Bisnovatyi-Kogan G., Blinnikov S., Chechetikin V.M., Cherepaschuk A.M., Khriplovich I., Lipunov V.M., Lukash V.N., Novikov I., Rudenko V.N., Starobinsky A.A. - **SERBIA**: Djordjevic G., Jovanovic P., Knezevic Z., Pankov-Hzvojevic M., Popovic L., Prodanovic T., Sijacki D., Simic S. - **SLOVAKIA**: Balek V. - SLOVENIA: Cadez A., Gomboc A., Zavrtanek D. - **SOUTH AFRICA**: Larena J., Maharaj S. - **SPAIN**: Elizalde E., Ibanez J., Perez M.J., Verdaguer E. - **SWEDEN**: Abramowicz M.A., Marklund M., Ryde F. - **SWITZERLAND**: Durrer R., Jetzer P. - **TURKEY**: Aliev A., Gurses M. - **UKRAINE**: Novosyadlyj B., Zaslavskii O., Zhuk A. - **UNITED ARAB EMIRATES**: Fernini I. - **UNITED KINGDOM**: Cruise A.M., Frenk Carlos S., Green M., Mavromatos N., Perry M., Willingale R. - **USA**: Abel T., Ashtekar A., Bardeen J., Carlstrom J., Cornish N., Dermer C., Fan X., Flanagan E., Fraschetti F., Fryer C., Incera V., Jantzen R.T. (chairperson), Kolb R., Laguna P., Lousto C., Madau Piero, Mathews Grant, Matzner Richard, Melia Fulvio, Mester John, Michelson Peter, Nordtvedt Kenneth, Parker Leonard, Pretorius F., Pullin J., Shapiro I., Shapiro S., Shoemaker D., Smoot G., Stiavelli M., Teukolsky S., van Nieuwenhuizen P., Zhang B. - **UZBEKISTAN**: Ahmedov B., Zalaletdinov R.M. - **VATICAN CITY**: Gionti G. - **VENEZUELA**: Fuenmayor E. - **VIETNAM**: Long H.N.



ICRA: Dipartimento di Fisica - P.le Aldo Moro, 5 - 00185 Roma - Italy - ICRANet - Piazza della Repubblica, 10 - 65122 Pescara - Italy - Contacts: mg16@icranet.org

THE MARCEL GROSSMAN MEETINGS

Since 1975, the Marcel Grossman Meetings have been organized in order to provide opportunities for discussing recent advances in gravitation, general relativity and relativistic field theories, emphasizing mathematical foundations, physical predictions and experimental tests. The objective of these meetings is to elicit exchange among scientists that may deepen our understanding of space-time structures as well as to review the status of ongoing experiments aimed at testing Einstein's theory of gravitation and relativistic field theories either from the ground or from space. Previous meetings have been held in Trieste (1975) and (1979), Shanghai (1982), Rome (1985), Perth (1988), Kyoto (1991), Stanford (1994), Jerusalem (1997), Rome (2000), Rio (2003), Berlin (2006), Paris (2009), Stockholm (2012) and Rome (2015-2018). Interested scientists should address a member from any one of the organizing committees or the conference secretariat.

INTERNATIONAL ORGANIZING COMMITTEE

Blair D., Choquet Bruhat Y., Damour T., De Bernardis P., Everitt C.W.F., Fryer C., Haensch T., Henneaux M., Jones C., Kerr R., Kleinert H., Kunz J., Laemmerzahl C., Longair M., Mirabel F., Mirzoyan R., Piran T., Rueda J., Ruffini R. (chairperson), Sasaki M., Sato H., Sunyaev R., 't Hooft G., Weinberg S., Yau S-T., Zhang B.

LOCAL ORGANIZING COMMITTEE

Adamo C., Bianco C.L., Brandolini G.A., di Niccolo C., Latorre S., La Selva D., Li L., Loppini A., Natale E., Verzulli D., Vereshchagin G.V. (chairperson), Wang Y.

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50TH ANNIVERSARY OF "INTRODUCING THE BLACK HOLE"

Plenary sessions include
MG16 Individual awards:
Demetrios Christodoulou, Gerard 't Hooft, Tsvi Piran, Steven Weinberg
MG16 Institutional award: Spektrum-Roentgen-Gamma (SRG) mission to S.A. Lavochkin association, Max Planck Institute for extraterrestrial physics (MPE), Space Research Institute (IKI) of the Russian Academy of Sciences.
Monday: Events in relativistic astrophysics
Speakers: Ruffini R., Sunyaev R., Kramer M., Miller-Jones J., Mirabel F.
Tuesday: Black holes and the Quantum
Speakers: Maldacena J., Almheiri A., 't Hooft G., Dafermos M., Kleinerman S., Ashtekar A., Wilczek F., Haxton W.
Wednesday: Lambda CDM tensions
Speakers: Efstathiou G., Scolnic D., Kamionkowski M., Freedman W., Natarajan P., Verde L.
Thursday: Black holes in GRBs
Speakers: Kerr R.P., Ha Y. K., Amati L., Pian E., Arguelles C. R.
Precision tests
Speakers: Li D., Liu J., Aspelmeyer M., Laemmerzahl C., Heinzel G., Ciufolini I.
Friday: Massive stars
Speakers: De Mink S., Langer N., Bicak J. and Ledvinka T., De Mitri I., Moradi R., Cella G.
Physics behind stellar collapse
Speakers: Fryer C., Laguna P., Kaspi V., Zhang B.
Saturday: Current and future missions
Speakers: Yuan W., Tashiro M. S., Liu R., Zhang S-N.
Future missions
Speakers: Hernanz M., J. L. Atteia, Hinton J.A., White N., Genzel R.
Round tables
Tuesday: New results from SRG/eRosita, Solar neutrinos and Borexino; ***Wednesday:*** Precision cosmology;
Friday: GRB170817A; ***Saturday:*** What is in our Galactic center?
Public lectures
Mirzoyan R., Qadir A., Bagheri M., Halzen F.
Parallel sessions
Accretion, Active Galactic Nuclei, Alternative Theories, Black Holes: Theory and Observations/Experiments, Binaries, Boson stars, Cosmic Microwave Background, Cosmic Strings, Dark Energy and Large Scale Structure, Dark Matter, Education, Exact Solutions, Early Universe, Fundamental Interactions and Stellar Evolution, Fast Transients, Gravitational Waves, High Energy, History of Relativity, Neutron Stars, Precision Tests, Quantum Gravity, Strong Field, White Dwarfs

Chandra X-ray image of GRB170817A at 110 days
Credit: NASA/CXC/M.Weiss

THE MARCEL GROSSMAN MEETINGS

Since 1975, the Marcel Grossman Meetings have been organized in order to provide opportunities for discussing recent advances in gravitation, general relativity and relativistic field theories, emphasizing mathematical foundations, physical predictions and experimental tests. The objective of these meetings is to elicit exchange among scientists that may deepen our understanding of space-time structures as well as to review the status of ongoing experiments aimed at testing Einstein's theory of gravitation and relativistic field theories either from the ground or from space. Previous meetings have been held in Trieste (1975) and (1979), Shanghai (1982), Rome (1985), Perth (1988), Kyoto (1991), Stanford (1994), Jerusalem (1997), Rome (2000), Rio (2003), Berlin (2006), Paris (2009), Stockholm (2012) and Rome (2015-2018). Interested scientists should address a member from any one of the organizing committees or the conference secretariat.

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MG16

MARCEL GROSSMANN AWARDS

Online Meeting, 2021

ICRANet and ICRA

MG XVI

MARCEL GROSSMANN AWARDS

ONLINE MEETING 2021

and

TEST

July 5, 2021, online

Individual Awards

Goes to
DEMETRIOS CHRISTODOULOU
"For his many lasting contributions to the foundation of mathematical physics including the dynamics of relativistic gravitational fields. Notably for: contributing in 1971, at the age of 19, to derive with Remo Ruffini the mass-energy formula of black holes as a function of their angular momentum, charge and irreducible mass. Christodoulou turned then to the study of partial differential equations and mathematical physics, to which he remained dedicated for the rest of his career. Highlights in this area include the theoretical discovery of the nonlinear memory effect of gravitational waves (Phys. Rev. Letters 1991), the monograph (1993) in collaboration with Sergiu Klainerman on the global nonlinear stability of the Minkowski spacetime, the monograph (2009) on the formation of black holes in pure general relativity by imploding gravitational waves, and the monographs (2007 and 2019) on the formation and further development of shocks in fluids."

Goes to
GERARD 't HOOFT
"for his persistent devotion to the study of the quantum field theory boundary conditions at the black hole horizon".

Goes to
TSVI PIRAN
"for extending Relativistic astrophysics across international frontiers, a true companion in the search for the deeper meaning of Einstein's great theory".

Goes to
STEVEN WEINBERG
"for unwavering support for the MG meetings since their inception, a true companion in the search for the deeper meaning of Einstein's great theory".

Institutional Awards

"for the creation of the world's best X-ray map of the entire sky, for the discovery of millions of previously unknown accreting supermassive black holes at cosmological redshifts, for the detection of X-rays from tens of thousands of galaxy clusters, filled mainly with dark matter, and for permitting the detailed investigation of the growth of the large-scale structure of the universe during the era of dark energy dominance".

Goes to:
S.A. LAVOCHKIN ASSOCIATION
- presented to its Designer General **Alexander Shirshakov**

MAX PLANCK INSTITUTE FOR EXTRATERRESTRIAL PHYSICS (MPE)
- presented to Professor **Peter Predehl**, Principal Investigator of eROSITA

SPACE RESEARCH INSTITUTE (IKI) OF THE RUSSIAN ACADEMY OF SCIENCES
- presented to Professor **Rashid Sunyaev,** Principal Investigator of SRG Observatory in Russia

Each recipient is presented with a silver casting of the TEST sculpture by the artist A. Pierelli. The original casting was presented to His Holiness Pope John Paul II on the first occasion of the Marcel Grossmann Awards.

Professor **DEMETRIOS CHRISTODOULOU**

"For his many lasting contributions to the foundation of mathematical physics including the dynamics of relativistic gravitational fields. Notably for: contributing in 1971, at the age of 19, to derive with Remo Ruffini the mass-energy formula of black holes as a function of their angular momentum, charge and irreducible mass. Christodoulou turned then to the study of partial differential equations and mathematical physics, to which he remained dedicated for the rest of his career. Highlights in this area include the theoretical discovery of the nonlinear memory effect of gravitational waves (Phys. Rev. Letters 1991), the monograph (1993) in collaboration with Sergiu Klainerman on the global nonlinear stability of the Minkowski spacetime, the monograph (2009) on the formation of black holes in pure general relativity by imploding gravitational waves, and the monographs (2007 and 2019) on the formation and further development of shocks in fluids."

Demetrios Christodoulou

It was back in 1967 that Achille Papapetrou mentioned the case of the 16 year old Demetrios Christodoulou to John Archibad Wheeler. Wheeler interviewed Demetrios in Paris and brought him immediately to Princeton where he was registered as an undergraduate at the university. After one year he entered the graduate school and started collaborating with me. At the time I was working with Wheeler on the effective potential approach to geodesics co-rotating and counter-rotating (see e.g. reference in The Classical Theory of Fields (Landau and Lifshitz, 1980) in the Kerr metric (later renamed as ISCO; see e.g. (Gravitation Misner, Thorne, Wheeler. 1973). In parallel, Frank Zerilli was working on the gravitational radiation emitted by the fall of a test particle in a Schwarzschild black hole (Zerilli 1970). From these limited conceptual arena Charles Misner and later Kip Thorne launched a program for the detection of gravitational waves on the Earth; see e.g. Misner 1974, Abbott et al. 2016, Abbott et al. 2017. See however Davis et al. 1972, Rodriguez et al. 2018 and J.A. Rueda et al. 2018.

A new approach started with the arrival of Demetrios: he was just creating mathematics following his needs. We identified the reversible and irreversible transformations of a Kerr black hole. Wheeler advanced a thermodynamic analogy. I addressed the need of identifying the concept of irreducible mass(from the Italian "irriducibile"), and was Demetrios's contribution to integrate, overnight, the differential equation for infinitesimal reversible transformations which led to the finite mass-energy formula of a Kerr black hole. That evening, while walking back home through IAS woods, I expressed to Wheeler the great relevance of the newly found formula by Demetrios and proposed to let Demetrios be the single author of this article, admiring his great mathematical talent. Wheeler agreed. The Editor of PRL objected since in that two pages article the Fig. 2 by Wheeler and myself was still unpublished. Actually that Fig. 2 followed a discussion I previously had with Penrose in Florence (Penrose 1961) which allowed us to present there, for the first time, a "Penrose Process". Some difficulties in achieving this process were obvious from the example in Fig. 2, which Roger later recognized himself (Penrose & Floyd 1971). The Editor finally agreed on our written request and the paper appeared on September 17, 1970 (Christodoulou, 1970). On January 1971 appeared my article with Johnny introducing the Black Hole (Ruffini & Wheeler, 1971), with the new physics we were developing in Princeton, including the concept of the "ergosphere". On march 1 1971 we submitted the mass formula of the Kerr Newmann metric, including the relation between the surface area of the horizon and the irreducible (Christodoulou & Ruffini, 1971). On March 11, 1971 the same results were independently confirmed by Steven Hawking, extending further the applicability of our equation (Hawking 1971).

The thesis was successfully discussed by a committee including Eugene Wigner (see Fig. 1), one of the closest collaborators of Albert Einstein and David Wilkinson (see Fig. 2), the head of the NASA WMAP mission, and Johnny and myself as supervisors. The new message was clear: Black Holes, far from being a

sink of energy, were energy sources emitting “in principle” 50% of their mass energy, being extractable (Christodoulou & Ruffini, 1971).

Fig. 1 and Fig. 2: Demetrios during his thesis presentation with Eugene Wigner (Fig. 1) and David Wilkinson (Fig.2). Myself and Johnny were supervisors, ready to intervene in case of need, but no need of intervention was necessary! Wigner elaborated the aphorism of Niels Bohr "Interesting = wrong" in the most definite "very interesting if true = totally wrong".

Demetrios turned soon to the study of partial differential equations and mathematical physics, to which he dedicated for the rest of his career and results were published in four monographs: (Christodoulou and Klainerman 1994, Christodoulou 2007, Christodoulou 2009, Christodoulou 2019). In 1968, Johnny proposed to Demetrios the collapse of a "geon" composed of massless scalar field as a second topic for his thesis. It took almost forty years for him to solve this problem, extended by Demetrios to the focusing of gravitational waves leading to black hole formation (Christodoulou 2009).

Fig. 3: Prof. Remo Ruffini receiving the Cressy Morrison Award of the New York Academy of Sciences, 1972 for the discovery of the first Black Hole in our galaxy Cygnus X1.

A "long march" started on 12 December 1970 with the launch of the Uhuru satellite by Riccardo Giacconi. Early in 1971 an almost daily conversation with him and Herb Gursky at the Smithsonian Astrophysical Observatory, leading to the discovery of binary X-ray sources. This was soon followedby the announcement of Cygnus X1 identified as the first black hole in our galaxy (Ruffini 1973); see e.g. Gursky & Ruffini 1975, which contained as well the first publicannouncement of the Discovery of Gamma Ray burst, as well as Giacconi & Ruffini 1980, 2009; see Fig.3 and 4).

Fig. 4: In the second row, from left to right, there are, among others: E. T. Newman, S. Chandrasekhar (Nobel 1983), R. Giacconi (Nobel 2002), R. Ruffini, A. Treves, A. Hewish (Nobel 1974), D. Arnett, J.H. Taylor (Nobel 1993), J. Wilson, R. Penrose (Nobel 2020), as well as J. Bahcall, T. Damour, T. Piran et al..

Today, after fifty years, this "long march" has reached a definite result: through the grandest observational multi-wavelength effort in the history of mankind, from space, ground and underground observatories, we are finally finding evidence that black holes are "alive" and their "extractable energy" in our mass formula (Christodoulou & Ruffini, 1971), is the energy source of the most energetic cosmological sources: gamma ray bursts (GRBs),the active galactic nuclei (AGNs) as well as the ultra-high energy cosmic rays (UHECRs) (Ruffini et al. 2021 and references therein). Their "inner engine", has three independent components: 1) a Kerr black hole which is neither in a stationary state nor in vacuum, 2) a background magnetic field aligned with the black hole rotation axis, and 3) an extremely diluted fully ionized plasma (Moradi et al. 2021).There is no role in this inner engine for ISCO. Indeed a new electro dynamical field equations describe the synchrotron radiation emitted close to the black hole horizon, they point to a discrete and repetitive emission of "blackholic quanta" in the MeV and in the GeV. The magnitudes and the emission time scales of these quanta, for M87 and GRB 130427A, are expressed as a function of the above three parameters (Rueda & Ruffini, 2021). A long lasting GeV emission with a luminosity decreasing as a temporal power law, allows for the first time in GRBs, the determination of the black hole mass and spin as well as their time evolution perfectly fulfilling our mass energy formula (Christodoulou & Ruffini, 1971): a long lasting emission process profoundly different from the traditional process of continued gravitational contraction.

Remo Ruffini

*P*rofessor **GERARD ’t HOOFT**

“for his persistent devotion to the study of the quantum field theory boundary conditions at the black hole horizon”.

Prof. Gerard ’T Hooft

Prof. Gerard ’t Hooft has been a full Professor at the Utrecht University (the Netherlands), since 1977. Nowadays, he is an Emeritus Professor at that University. During his career, he has paid extended scientific visits to CERN (Geneva), Harvard, Stanford, Princeton and Duke University, NC.
In 1999, together with M. Veltman, he received the Nobel Prize in Physics, awarded by The Royal Swedish Academy of Sciences, *“For elucidating the quantum structure of electroweak interactions in physics”*.
Prof. ’t Hooft main subjects of research includes:

- Gauge Theories for the sub-atomic particles and forces, various aspects and ingredients of what is now called "The Standard Model of the sub-atomic particles: renormalizability, topological features such as magnetic monopoles and instantons, 1/N expansions.
- Theories for the quantization of the gravitational force and black holes: producing models for the quantum properties of a black hole, as derived from Standard Model and General Relativity alone; its topological features such as antipodal identification.
- Fundamental theories underlying quantum mechanics, in particular returning determinism and reality to the dynamics of the tiniest material entities in his universe.

Prof. ’t Hooft has been awarded the Wolf Prize of the State of Israel (1982), the Pius XI Medal (Vatican city, 1983), the Lorentz Medal (KNAW Amsterdam, 1986) as well as the Spinoza Premium (Netherlands Organization for Scientific Research NWO, 1995).

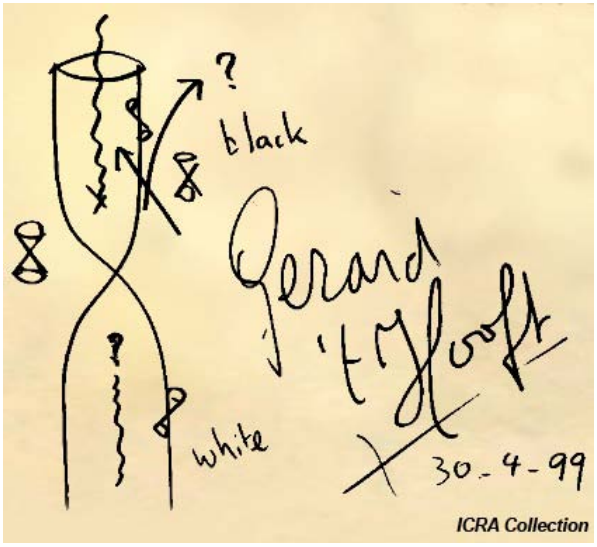

Fig. 2: The signature of Gerard ‘t Hooft on the wall of ICRA Room 301 (April 4, 1999).

A special event took place at ICRA on April 30, 1999. Prof. Ruffini invited Gerard ’t Hooft to Rome to discuss a boundary condition for a quantum field on the black hole horizon, a topic Prof. Ruffini discussed in a previous article "Black-hole evaporation in the Klein-Sauter-Heisenberg-Euler formalism" with Thibault Damour (Phys. Rev. D 14, 332, 1976), but which needed to be examined in more detail. Prof. Ruffini planned to direct Gerard’s attention to some specific aspects of this problem. Because we have traditionally been very attentive in spending ICRA travel funds, ICRA offered Gerard to come to Rome on a reduced fare weekend ticket arriving Friday and departing Monday. He had a great relaxing weekend together with Prof. Ruffini following his seminar, which among other things allowed Gerard to sign the wall in our ICRA Room (see Fig. 2) , and during this splendid Rome spring weekend he also was able to find a missing factor of 2 in a formula in Prof. Ruffini’s 1971 paper with Demetri Christodoulou on the black hole mass formula. The following October, Gerard received the Nobel prize, which meant that we could no longer get away with bringing him to Rome on a cheap ticket! Ever since Gerard has been in our MG IOC helping us with the preparation of the meetings. We are very happy to announce this MG16 Award to Gerard ’t Hooft with the motivating phrase *"for his persistent devotion to the study of the quantum field theory boundary conditions at the black hole horizon"*.

Remo Ruffini

Professor **TSVI PIRAN**

"for extending relativistic astrophysics across international frontiers, a true companion in the search for the deeper meaning of Einstein's great theory".

Prof. Tsvi Piran

Tsvi Piran is the emeritus Schwartzmann professor at the Hebrew University of Jerusalem. He obtained his PhD in Physics, in 1976 from the Hebrew University working on the collisional Penrose process. Piran returned to the Hebrew University at 1981after being a post doc at Oxford and Texas and a long term member at the IAS at Princeton. In 1982 he initiated and directed the first ever summer school on Gravitational Waves that took place at Les Houches. Piran was a visiting professor at Harvard, Columbia and New York and a Moore scholar at Caltech.

Piran's research deals with numerous aspects of relativistic astrophysics, ranging from the foundation of numerical relativity to modeling of observer relativistic phenomena and analytic work on the fate of gravitational collapse. Piran's research work focuses mostly on black holes and in particular on gamma-ray bursts. He was among the first to point out their cosmological origin and their association with merging neutron stars and heavy r-process nucleo synthesis. Piran's achievements were recognized in the 2019 EMET prize for Physics.

Professor **STEVEN WEINBERG**

"for unwavering support for the MG meetings since their inception, a true companion in the search for the deeper meaning of Einstein's great theory".

Steven Weinberg. Photo courtesy of Matt Valentine.

Steven Weinberg is a member of the Physics and Astronomy Departments at The University of Texas at Austin. His research has covered a broad range of topics in quantum field theory, elementary particle physics and cosmology. He has been honored with numerous awards, including the Nobel Prize in Physics, the National Medal of Science, the Heinemann Prize in Mathematical Physics and in 2020, the Breakthrough Prize. He is a member of the US National Academy of Sciences, Britain's Royal Society, and other academies in the USA and abroad. The American Philosophical Society awarded him the Benjamin Franklin Medal, with a citation that said he is "considered by many to be the preeminent theoretical physicist alive in the world today." His books for physicists include *Gravitation and Cosmology*, the three-volume work *The Quantum Theory of Fields*, *Cosmology* and published in April of 2021, *Foundations of Modern Physics*. Educated at Cornell, Copenhagen, and Princeton, he also holds honorary degrees from sixteen other universities. He taught at Columbia, Berkeley, M.I.T., and Harvard, where he was Higgins Professor of Physics, before coming to Texas in 1982.

Fig. 1: Chuo Pei Yuan and Cheng Ning Yang at MG2 in Trieste, Italy (1979).

The Sixteenth Marcel Grossmann Meeting (MG16) is a very special one in many respects: it will take place during a pandemic and in spite of the many difficulties, we have decided not to postpone it but to organize it as a virtual meeting. As described on the MG series webpage, these meetings started in 1975 with the first meeting at the International Centre for Theoretical Physics (ICTP) in Trieste (Italy) that I organized with Nobel Prize winner Abdus Salam. A second meeting followed in 1979, with a significantly larger participation including Nobel Laurate Cheng Ning Yang and a Chinese delegation led by Chuo Pei Yuan (see Fig. 1), including Fang Li-Zhi who had accompanied me during my entire first visit to China in 1979. The first truly international MG meeting followed in 1982 in Shanghai (China):this represented an especially important step forward both for the meeting and for China. A multi-millennia *"motto"* in China, which was then proclaimed on banners everywhere, read *"Friends from all over the world are welcomed"*.

We were soon at an impasse over the participation of scientists from Israel, since no diplomatic relations existed between China and Israel at that time and the Israeli scientists were not to be allowed to attend the meeting. A long negotiation began. The boundary conditions were clearly set by Steven Weinberg, a member of the present MG16 IOC: no MG meetings on Einstein's theory of general relativity could occur without the participation of Israeli scientists. The intervention of Yuval Ne'emann, also a member of the MG IOC then as well as the Minister of Science of Israel (see Fig.2), proposed a compromise that would admit at least one Israeli scientist. I went to Beijing alone, meeting every morning for a week with 12 Chinese representatives led by Chuo Pei Yuan going over all possible options. I stayed in an isolated villa not far from Tiananmen Square, accompanied by the 3 volumes of Matteo Ricci (RI MA TO) to keep me company. No solution was in sight the entire week. At the last moment, just before my departure, an agreement was finally reached allowing two Israeli scientists into China. The historic compromise would admit Gerard Tauber and Tsvi Piran into China using a special ICRA travel document I had proposed for them to be able to participate in the meeting, accepted by the Chinese Ambassador in Rome. This modified the thousand year Chinese *"motto"* to read *"Scientists from all over the world are welcomed"*. The event was extremely beneficial for China and signaled the truly international nature of the MG meetings.

Fig. 2: From right to left: Chaim Weizmann, President of Israel; Yuval Ne'emann, Minister of Science of Israel; R. Ruffini.

I kept on meeting Tauber in the years which followed (see Fig. 3). Soon after, Yuval Ne'emann visited China. The development of bilateral relations, including military cooperation and economical tights, grow exponentially until the establishment of normal diplomatic relations between Israel and China in 1992.

Fig. 3: From right to left: Arrigo Finzi, Remo Ruffini, Gerard Tauber and Konrad Bleuler.

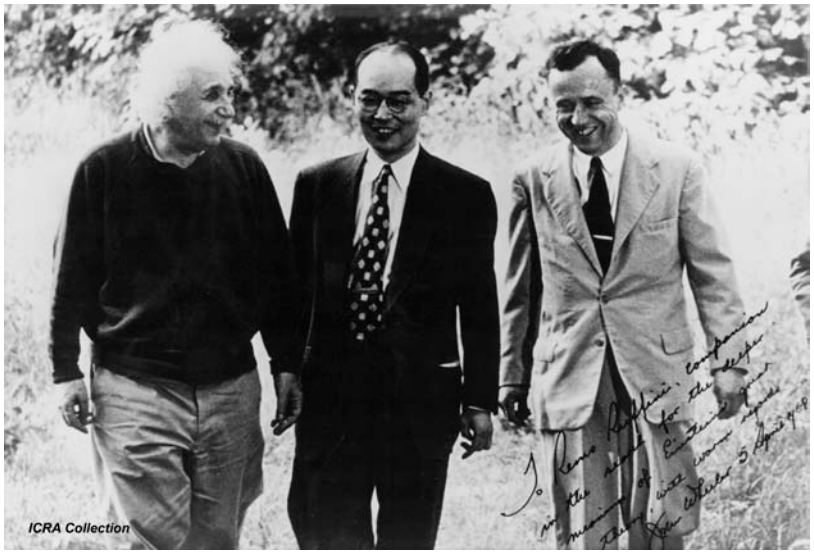

Fig. 4: Albert Einstein, Hideki Yukawa and John. A. Wheeler with a hand-written dedication to Remo Ruffini "To Remo Ruffini, companion in the search for the deeper meaning of Einstein great theory. With warm regards, John Wheeler 5 April 1968".

Given their key role played in the foundations of the MG meetings, I am very happy to propose on behalf of the MG16 IOC, two special Marcel Grossmann Individual Awards: one to Steven Weinberg for *"for unwavering support for the MG meetings since their inception, a true companion in the search for the deeper meaning of Einstein's great theory"* and another one to Tsvi Piran, *"for extending Relativistic astrophysics across international frontiers, a true companion in the search for the deeper meaning of Einstein's great theory"*, in the words of John A. Wheeler's photo dedication to myself (see Fig. 4).

Remo Ruffini

Institutional Awards for the Spektrum-Roentgen-Gamma (SRG) mission

"for the creation of the world's best X-ray map of the entire sky, for the discovery of millions of previously unknown accreting supermassive black holes at cosmological redshifts, for the detection of X-rays from tens of thousands of galaxy clusters, filled mainly with dark matter, and for permitting the detailed investigation of the growth of the large-scale structure of the universe during the era of dark energy dominance".

Goes to:
S.A. LAVOCHKIN ASSOCIATION
- presented to its Designer General **Alexander Shirshakov**

MAX PLANCK INSTITUTE FOR EXTRATERRESTRIAL PHYSICS (MPE)
- presented to Professor **Peter Predehl**, Principal Investigator of eROSITA

SPACE RESEARCH INSTITUTE (IKI) OF THE RUSSIAN ACADEMY OF SCIENCES
- presented to Professor **Rashid Sunyaev,** Principal Investigator of SRG Observatory in Russia

On Tuesday June 29, 2021, the following 31 Astro-Ph appeared:

1. https://arxiv.org/abs/2106.14517
2. https://arxiv.org/abs/2106.14518
3. https://arxiv.org/abs/2106.14519
4. https://arxiv.org/abs/2106.14520
5. https://arxiv.org/abs/2106.14521
6. https://arxiv.org/abs/2106.14522
7. https://arxiv.org/abs/2106.14523
8. https://arxiv.org/abs/2106.14524
9. https://arxiv.org/abs/2106.14525
10. https://arxiv.org/abs/2106.14526
11. https://arxiv.org/abs/2106.14527
12. https://arxiv.org/abs/2106.14528
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14. https://arxiv.org/abs/2106.14530
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28. https://arxiv.org/abs/2106.14547
29. https://arxiv.org/abs/2106.14548
30. https://arxiv.org/abs/2106.14549
31. https://arxiv.org/abs/2106.14550

S.A. LAVOCHKIN ASSOCIATION
presented to its Designer General **Alexander Shirshakov**

Dr Alexander Shirshakov

S.A. Lavochkin Association created the Navigator space platform carrying German eRosita and Russian ART-XC X-Ray Telescopes, organized the launch of SRG Orbital X-Ray Observatory to the second Lagrangian point of the Sun-Earth system at a distance of 1.5 million km from the Earth and managed the observatory flight and the daily reception of its scientific data on Earth for 23,5 months.

Dr Alexander Shirshakov, Designer General of the S.A. Lavochkin Association, is specialized in design, manufacture, testing, launch and control of S/C for scientific purposes. Among those S/C launched, there are the «Radiostron» Astrophysical Observatory (2011) and the «Spektr-RG» space observatory (2019), while the planned S/C launches are «Luna-25» and «Exomars».

Dr Shirshakov started his career in 1973, working as an engineer of the State Unitary Enterprise «NPO named by S.A. Lavochkin» in Khimki (Russian Federation). Starting from 1989 he has played multiple roles within the Lavochkin Association, been appointed head of the group, head of the sector, head of department, deputy head of the complex, head of the branch, director of the center, deputy head of the Design Bureau, deputy General Designer and deputy General Director.

Dr Shirshakov is an editorial board Member of the reviewed edition of «Vestnik of Lavochkin Association». Since 2017, he is also member of the General Designer council. He has been awarded Honored Mechanical engineer of the Russian Federation as well as Agency-level award of the Russian Federal Space Agency.

MAX PLANCK INSTITUTE FOR EXTRATERRESTRIAL PHYSICS (MPE)
presented to Professor **Peter Predehl**, Principal Investigator of eROSITA

Professor Peter Predehl

eROSITA is the soft X-ray telescope on-board the Russian-German Spektr-RG mission which was successfully launched from Baikonur on July 13, 2019 and placed in a halo orbit around the L2 point. 30 years after ROSAT, eROSITA performs an all-sky survey with an unprecedented sensitivity, spectral and angular resolution. Clusters of galaxies are the largest collapsed objects in the Universe. Their formation and evolution is dominated by gravity, i.e. Dark Matter, while their large scale distribution and number density depends on the geometry of the Universe, i.e. Dark Energy. X-ray observations of clusters of galaxies provide information on the rate of expansion of the Universe, the fraction of mass in visible matter, and the amplitude of primordial fluctuations which are the origin of clusters of galaxies and the whole structure of the universe. eROSITA has been designed to detect at least 100.000 clusters of galaxies and to detect systematically more than 3 Million obscured accreting Black Holes. eROSITA will also allow to study the physics of galactic X-ray source populations, like pre-main sequence stars, supernova

remnants and X-ray binaries. The eROSITA telescope consists of seven identical Wolter-1 mirror modules. A novel detector system has been developed by MPE on the basis of the successful XMM-Newton pn-CCD technology. MPE is the scientific lead institute of eROSITA, responsible for the development of the instrument, the operation, the analysis software and data archive. Peter Predehl led this development as Principal Investigator of eROSITA and German lead scientist of the SRG mission for more than 15 years until the completion of the first of eight surveys in 2020. At this time eROSITA has already discovered more than 1 Million X-ray sources, more than all X-ray observatories of the last 50 years together. This demonstrates, that the design goals of the mission will easily be fulfilled.

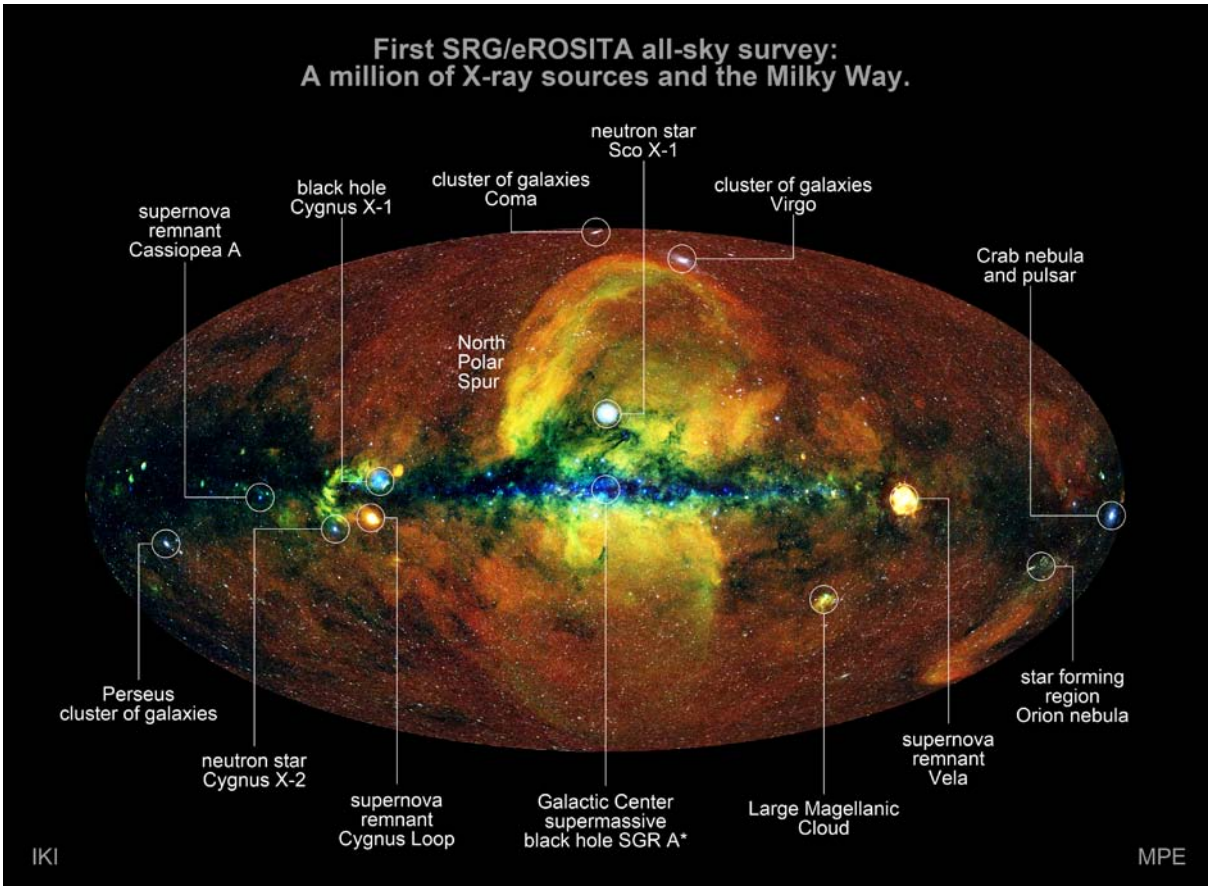
SPACE RESEARCH INSTITUTE (IKI) OF THE RUSSIAN ACADEMY OF SCIENCES
presented to Professor **Rashid Sunyaev**

Professor Rashid Sunyaev

Space Research Institute (IKI) of the Russian Academy of Sciences was responsible for developing the overall concept and scientific program of the SRG Orbital observatory and played a leading role in developing the ART-XC telescope and the entire SRG observatory as part of the Russian space science program carried out by Roskosmos Corporation in the interests of the Russian Academy of Sciences.

During the flight to the L2 point of the Sun-Earth system, SRG with German (eRosita) and Russian (ART-XC named after Mikhail Pavlinsky) X-Ray Telescopes aboard performed calibrations and long duration Performance Verification observations of a dozen of targets and deep fields. Starting in the middle of December 2019, the SRG scanned the whole sky three times. During these scans, SRG discovered two million point X-Ray sources: mainly quasars, stars with hot and bright coronae, and more than 30 thousand clusters of galaxies. There is a competition and synergy in the search for clusters of galaxies between SRG and the ground-based Atacama Cosmology and South Pole Telescopes, which are searching for clusters of galaxies in microwave spectral band using Sunyaev-Zeldovich effect. SRG provided the X-Ray map of the whole sky in hard and soft bands, the last is now the best among existing. The huge samples of the X-ray selected quasars at the redshifts up to z=6.2 and clusters of galaxies will be used for well-known cosmological tests and detailed study of the growth of the large scale structure of the Universe during and after reionization. SRG/eRosita is discovering every day several extragalactic objects which increased or decreased their brightness more than 10 times during half of the year after the previous scan of the same one-degree wide strip on the sky. A significant part of these objects has observational properties similar to the Events of Tidal Disruption of a star orbiting in the vicinity of the supermassive black hole. ART-XC discovered a lot of bright galactic and extragalactic transients.

Rashid Sunyaev is the Principal Investigator of SRG mission in Russia, director-emeritus of the Max-Planck Institute for Astrophysics and Maureen and John Hendricks distinguished visiting professor of the Institute for Advanced Study, Princeton.



15th Marcel Grossmann Meeting
July 2018, Rome, Italy

Institutional Awards

PLANCK SCIENTIFIC COLLABORATION (ESA)

"for obtaining important constraints on the models of inflationary stage of the Universe and level of primordial non-Gaussianity; measuring with unprecedented sensitivity gravitational lensing of Cosmic Microwave Background fluctuations by large-scale structure of the Universe and corresponding B-polarization of CMB, the imprint on the CMB of hot gas in galaxy clusters; getting unique information about the time of reionization of our Universe and distribution and properties of the dust and magnetic fields in our Galaxy"

- presented to Jean-Loup Puget, the Principal Investigator of the High Frequency Instrument (HFI)

HANSEN EXPERIMENTAL PHYSICS LABORATORY AT STANFORD UNIVERSITY

"to HEPL for having developed interdepartmental activities at Stanford University at the frontier of fundamental physics, astrophysics and technology"

- presented to Research Professor Leo Hollberg, HEPL Assistant Director

Individual Awards

LYMAN PAGE

"for his collaboration with David Wilkinson in realizing the NASA Explorer WMAP mission and as founding director of the Atacama Cosmology Telescope"

RASHID ALIEVICH SUNYAEV

"for the development of theoretical tools in the scrutinising, through the CMB, of the first observable electromagnetic appearance of our Universe"

SHING-TUNG YAU

"for the proof of the positivity of total mass in the theory of general relativity and perfecting as well the concept of quasi-local mass, for his proof of the Calabi conjecture, for his continuous inspiring role in the study of black holes physics"

14th Marcel Grossmann Meeting
July 2015, Rome, Italy

Institutional Award
EUROPEAN SPACE AGENCY (ESA)
"for the tremendous success of its scientific space missions in astronomy, astrophysics, cosmology and fundamental physics which have revolutionized our knowledge of the Universe and hugely benefited science and mankind"

- presented to its Director General Johann-Dietrich Woerner

Individual Awards
KEN'ICHI NOMOTO
"for heralding the role of binary systems in the evolution of massive stars"

MARTIN REES
"for fostering Research in black holes, gravitational waves and cosmology"

YAKOV G. SINAI
"for applying the mathematics of chaotic systems to physics and cosmology"

SACHIKO TSURUTA
"for pioneering the physics of hot neutron stars and their cooling"

FRANK C.N. YANG
"for deepening Einstein's geometrical approach to physics in the best tradition of Paul Dirac and Hermann Weyl"

T.D. LEE (award received by Yu-Qing Lou on behalf of Prof. T.D. Lee)
"for his work on white dwarfs motivating Enrico Fermi's return to astrophysics and guiding the basic understanding of neutron star matter and fields"

13th Marcel Grossmann Meeting
July 2012, Stockholm, Sweden

Institutional Award
ALBANOVA
for its innovative status as a joint institute established by Stockholm University and the Royal Institute of Technology and for fostering contributions to cosmology and astrophysics in the profound scientific tradition established by Oskar Klein.

- presented to the Rector of Stockholm University, Prof. Kåre Bremer.

Individual Awards
DAVID ARNETT
for exploring the nuclear physics and yet unsolved problems of the endpoint of thermonuclear evolution of stars, leading to new avenues of research in physics and astrophysics.

VLADIMIR BELINSKI and I.M. KHALATNIKOV
for the discovery of a general solution of the Einstein equations with a cosmological singularity of an oscillatory chaotic character known as the BKL singularity.

FILIPPO FRONTERA
for guiding the Gamma-ray Burst Monitor Project on board the BeppoSAX satellite, which led to the discovery of GRB X-ray afterglows, and to their optical identification.

12th Marcel Grossmann Meeting
July 2009, Paris, France

Institutional Award
INSTITUT DES HAUTES ÉSTUDES SCIENTIFIQUE (IHÉS)
for its outstanding contributions to mathematics and theoretical physics, and notably for having renewed basic geometrical concepts, and having developed new mathematical and physical aspects of spacetime.
- presented to Prof. Jean-Pierre Bourguignon

Individual Awards
JAAN EINASTO
for pioneering contributions in the discovery of dark matter and cosmic web and fostering research in the historical Tartu Observatory.

CHRISTINE JONES
for her fundamental contributions to the X-ray studies of galaxies and clusters tracing their formation and evolution and for her role in collaborations using clusters to study dark matter and in analyzing the effects of outbursts from supermassive black holes on the intracluster gas.

MICHAEL KRAMER
for his fundamental contributions to pulsar astrophysics, and notably for having first confirmed the existence of spin-orbit precession in binary pulsars.

11th Marcel Grossmann Meeting
July 2006, Berlin, Germany

Institutional Award
FREIE UNIVERSITÄT BERLIN
for the successful endeavor of re-establishing — in the spirit of the Humboldt tradition — freedom of thinking and teaching within a democratic society in a rapidly evolving cosmos
- presented to Dr. Dieter Lenzen, President of FUB

Individual Awards
ROY KERR
for his fundamental contribution to Einstein's theory of general relativity: "The gravitational field of a spinning mass as an example of algebraically special metrics."

GEORGE COYNE
for his committed support for the international development of relativistic astrophysics and for his dedication to fostering an enlightened relationship between science and religion.

JOACHIM TRUMPER
for his outstanding scientific contributions to the physics of compact astrophysical objects and for leading the highly successful ROSAT mission which discovered more then 200,000 galactic and extragalactic X-ray sources: a major step in the observational capabilities of X-ray astronomy and in the knowledge of our universe.

10th Marcel Grossmann Meeting
July 2003, Rio di Janiero, Brazil

Institutional Award
CBPF (Brazilian Center for Research in Physics)
for its role as a teaching and research institution and as a place originating fundamental physics ideas in the exploration of the universe.
- presented to its founders Cesar Lattes, Josè Leite Lopez and Jayme Tiomno

Individual Awards
YVONNE CHOQUET-BRUHAT AND JAMES W. YORK, JR.
for separate as well as joint work in establishing the mathematical framework for proving the existence and uniqueness of solutions to Einstein's gravitational field equations.

YUVAL NE'EMAN
for his contributions to science, epistimology, mathematics and physics from subnuclear to space sciences.

9th Marcel Grossmann Meeting
July 2000, Rome, Italy

Institutional Award
SOLVAY INSTITUTES
for identifying and recording in discussions by the protagonists the crucial developments of physics and astrophysics in the twentieth century.
- presented to Jacques Solvay

Individual Awards
CECILLE AND BRYCE DEWITT
for promoting General Relativity and Mathematics research and inventing the "summer school" concept.

RICCARDO GIACCONI
for opening, five successive times, new highways for exploring the Universe.

ROGER PENROSE
for extending the mathematical and geometrical foundations of General Relativity.

8th Marcel Grossmann Meeting
June 1997, Jerusalem

Institutional Award
HEBREW UNIVERSITY
for its role as a cradle of Science and Humanities and for hosting the manuscripts of Albert Einstein.
- presented to M. Magidor, President of the Hebrew University of Jerusalem

Individual Awards
TULLIO REGGE
for his contributions to the interface between mathematics and physics leading to new fields of research of paramount importance in relativisic astrophysics and particle physics.

FRANCIS EVERITT
for leading the development of extremely precise space experiments utilizing superconducting technology to test General Relativity and the Equivalence Principle.

7th Marcel Grossmann Meeting
June 1994, Stanford, USA

Institutional Award
SPACE TELESCOPE SCIENCE INSTITUTE
for its critical role in the direction and operation of the Hubble Space Telescope, a truly unique international laboratory for the investigation and testing of general relativity in the context of modern astrophysics and cosmology.
- presented to Peter Stockman

Individual Awards
SUBRAHMANYAN CHANDRASEKHAR
for his contributions to the analysis of gravitational phenomena from Newton to Einstein and especially for leading the way to relativistic astrophysics with the concept of critical mass for gravitational collapse.

JIM WILSON
for having built on his experience in nuclear physics, thermonuclear reactions, and extensive numerical simulation to create a new testing ground for the novel concepts of relativistic astrophysics.

6th Marcel Grossmann Meeting
June 1991, Kyoto, Japan

Institutional Award
RITP
for keeping alive first in Hiroshima and them in Kyoto research in relativity, cosmology, and relativistic field theory and the development of a school of international acclaim.
- presented to Professor K. Tomita

Individual Awards
MINORU ODA
for participating in the pioneering work of the early sixties in X-ray astronomy and for his subsequent molding of an agile and diversified Japanese scientific space program investigating the deepest aspects of relativistic astrophysics.

STEPHEN HAWKING
for his contributions to the understanding of spacetime singularities and of the large scale structure of the Universe and of its quantum origins.

5th Marcel Grossmann Meeting
August 1988, Perth, Australia

Institutional Award
THE UNIVERSITY OF WESTERN AUSTRALIA
for its contributions to relativistic astrophysics.
- presented to the Vice Chancellor, Professor Robert Smith

Individual Awards
SATIO HAYAKAWA
for his contributions to research in gamma, X-ray and infrared radiation as well as cosmic rays.

JOHN ARCHIBALD WHEELER
for his contributions to geometrodynamics and Einstein’s visions.

4th Marcel Grossmann Meeting
July 1985, Rome, Italy

Institutional Award
THE VATICAN OBSERVATORY
for its contributions to the origin and development of astrophysics.
- presented to His Holiness Pope John Paul II

Individual Awards
WILLIAM FAIRBANK
for his work in gravitation and low temperature physics.

ABDUS SALAM
for his work in unifying fundamental interactions.

TEST: **T**raction of **E**vents in **S**pace-**T**ime

Anna Imponente
National Gallery of Modern Art, Rome

The TEST sculpture provides an innovative example of interaction between science and art, not abstractly interpreted as a result of a subsequent critical analysis but indeed an active and creative collaboration between an astrophysicist and a sculptor.

In order to comprehend the meaning of collaboration between scientists and artists and to retrace its historical origin, we must go back to the Renaissance. There we find the so-called *Weltanschaung* and the idea of unitary art as a continuous and inseparable process of recognition of the structure of reality. This underlies the experience of Leonardo Da Vinci's talent, expressed in his drawings, of not separating scientific enquiry from artistic research.

In the seventeenth century, the "climb to the stars" of the stage machinery in baroque scenography, nourished by imagination, had loosened this link. It had coincided, on the one hand, with experimental Galilean sciences pursuing exact research towards a rational comprehension of the universe, and on the other hand, with the flourishing of the poetics of subjectivity, taste and feeling, the *beaux arts*, and a stratification of painting into specialistic genres.

In the nineteenth century, however, a new reversal of this trend can be observed: the scientific achievements of H.L. Helmholtz in the field of optics and of E. Chevreul in that of chemistry helps *pointillistes* painters in the separation of color. Furthermore, at the beginning of the twentieth century (1907) the Cubist revolution, which changes the concepts of space and time towards a simultaneity of vision, is synchronized with Einstein's theory of special relativity (1905).

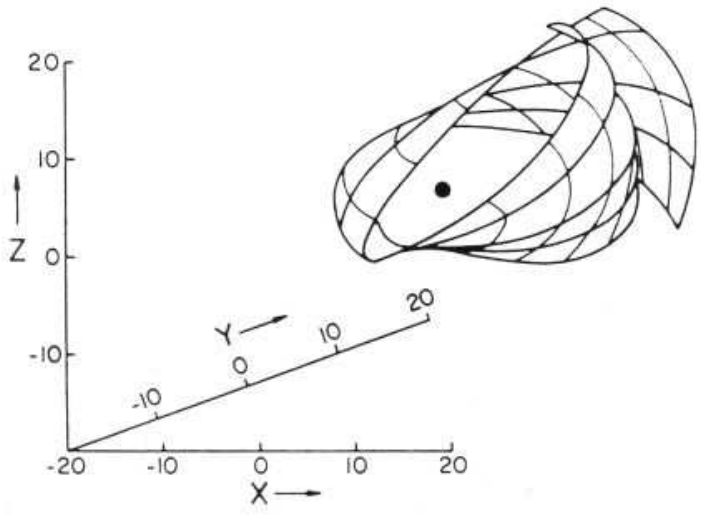
$$\dot{r} = \rho^{-2}\{[E(r^2+a^2) - a\Phi]^2 - \Delta(\mu^2 r^2 + K)\}^{1/2}$$

$$\dot{\theta} = \rho^{-2}\{K - (\Phi - aE)^2 - \cos^2\theta[a^2(\mu^2 - E^2) + \Phi^2 \sin^{-2}\theta]\}^{1/2}$$

$$\dot{t} = -a\rho^{-2}(aE\sin^2\theta - \Phi) + \rho^{-2}(r^2+a^2)\Delta^{-1}P$$

$$\dot{\phi} = -\rho^{-2}(aE - \Phi\sin^{-2}\theta) + a\rho^{-2}\Delta^{-1}P$$

$$E = .968\ ,\ \Phi = 2\ ,\ Q = 10\ ,\ a = e = 1/\sqrt{2}$$



Equations for a family of geodesics in a Kerr black hole and their graphical representation (*M. Johnston and R. Ruffini, 1974*).

The relationship between Remo Ruffini and Attilio Pierelli was not one of director/implementer nor could it exactly be defined as a four-handed performance. It has instead been a line of work suggested to the artist by a graphic design which had already been scientifically tested and computerized by M. Johnston and Ruffini at Princeton University in 1974.

This scientific investigation concerned the calculation of the geometric motion of five particles moving in space-time according to the application of a solution of Einstein's equations; the *in vitro* materialization and the visible replica of the discovery of a phenomenon existing in our own galaxy, namely the *black hole*, consisting of a stellar mass which is sucked into itself by gravitational collapse under the effect of its own self-gravity.

The encounter between Ruffini and Pierelli was not just a coincidence. On the one hand, there is the scientist, who in investigating astrophysical laws has always matched the exactness of results with the acknowledgement of a natural elegance of formulas, approaching an aesthetic outline of the detailed calculations. On the other hand, there is the sculptor, who appeases his eagerness for geometry by the contemplation of intricate reflecting symmetries and by perspective-illusive visions based on proportionate sizes, with the intention of proving the poetry of pure science before it becomes a technological adventure. In the theoretical formulation of his research on space, Pierelli has surveyed the history of mathematical thought and non-Euclidean geometries, deriving his hyperspatial shapes from the investigations of Gerolamo Saccheri, a Jesuit philosopher and mathematician of the seventeenth century.

The intuition of the aesthetic potential of this new form derived from the integration of Einstein's equations and describing the geodesics or trajectories of bodies around a black hole is compared by Ruffini to the "Greeks' discovery of π and the circle, which led to Hellenic architecture and the column" (interview with R. Ruffini by F. Bellonzi, Rome, 1985). Initially in 1981 the structural novelty of this form was understood by the architect Maurizio Sacripanti when he considered it as a space one can enter with one's own body and perceive directly with one's senses (M. Sacripanti in *Catalogo Roma*, Palazzo delle Esposizioni, 1981).

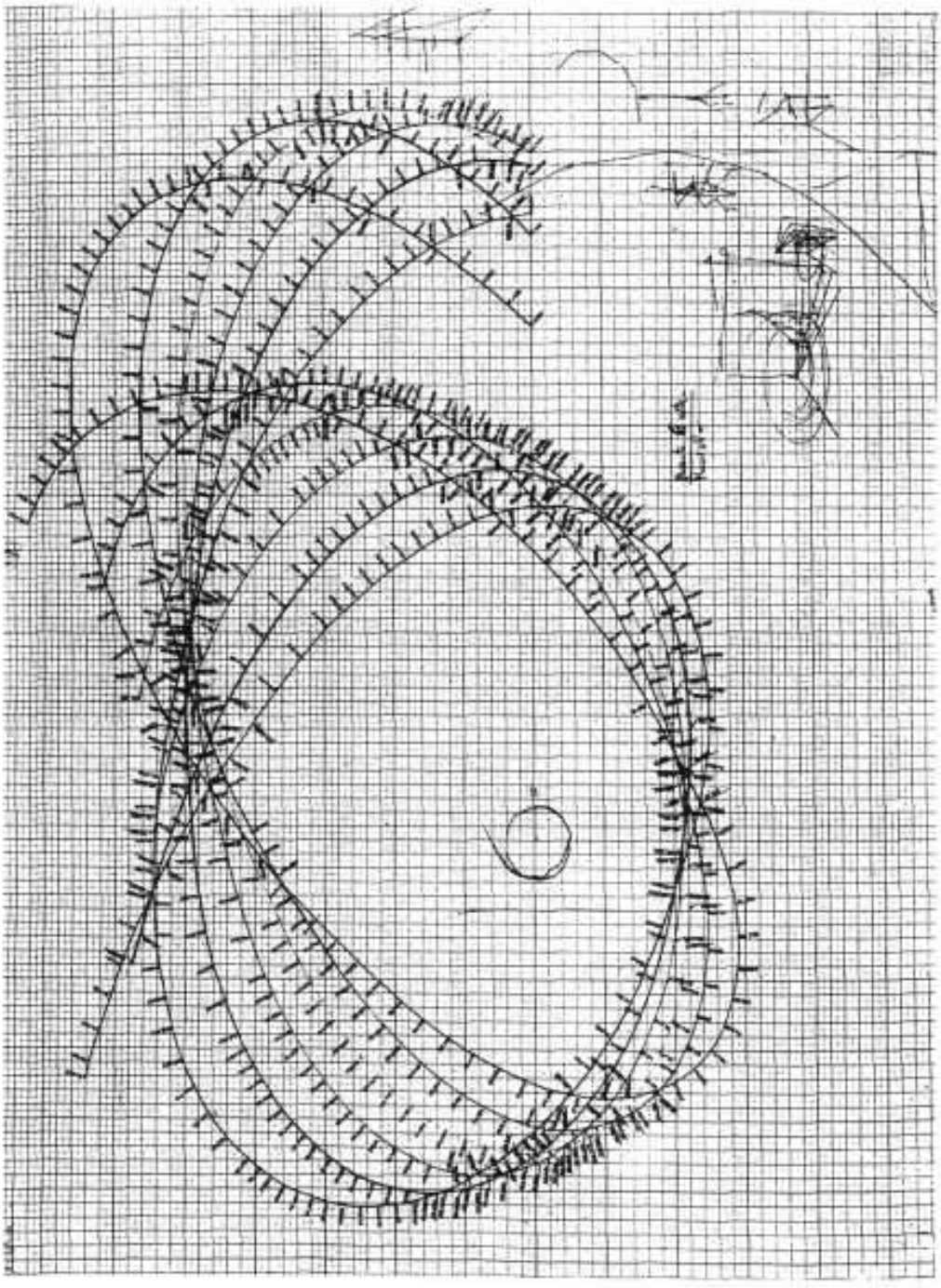
The initiation of this new work has the flavor of a challenge that the sculptor makes to himself, namely to represent the trajectories in a plastic form given their spatial co-ordinates—height, width and length—and to reinterpret them as an aesthetic object, using his own judgement to verify its artistic coherence.

TEST, sculpture by A. Pierelli, photo by S. Takahashi.

The realization of this project seems to be conceptually complex and revolutionary. It is meant to describe a motion, but not a terrestrial one, as the futurists and Boccioni had already done in 1913 with the famous sculpture *Unique forms in space continuity*. Nor should it be the motion of a body set free in the earth's gravitational field, which would fall either vertically or with elliptical or hyperbolic motions. Instead it should resemble a Möbius strip without being so simple, since it would be differentially dragged by the rotational field of the black hole in the geometry of space-time. Hence the acronym TEST which stands for "Traction of Events in Space-Time." Thus the sculpture has no priviledged interpretational directions and no supporting pedestal which might associate it with a central perspective view: no "top" or "bottom," no "right-side" or "left-side." Any orientation gives a complete and faithful realization.

Rather one should imagine it in rotation, with its surface being independent of any relation with the source of natural light ("ambientation" is the fundamental issue of sculpture), ignoring any possible atmospheric effect; in other words, the opposite of a "Mobile" of Calder which awaits a gust of wind to reanimate itself and come alive. Here, the metal light alone outlines and designs the vision of the rotating black hole. The transformation of this sequence of events into a solid form is portrayed by abstracting their properties and reducing everything to a direct perception of its essence, a *Wesenschau*. This representation does not lend itself to psychological or science-fictional interpretation and suggestion; the collective imagination can perceive and attain an emotional projection and exemplification of the universe, of egoism, since it involves a prehensile shape which absorbs and sucks in matter. Moreover, the title TEST, only by pure chance, includes the monogram "ET" which recalls the mythical encounter of a human being with the extraterrestrial of Steven Spielberg's fairy-tale film. There the emblematic image of the finger contact between the two had been borrowed from Michelangelo's *Creation of Man* in the Sistine Chapel while the return to space resembled a mythical ascension on the trail of the Christmas comet.

From a scientific point of view, the clear and lucid form of this sculpture might remind one of the application of mathematical logic to ideographic instantaneity that Giuseppe Peano carried out towards the end of the last century (G.C. Argan, 1985). And from a properly artistic perspective, it can be related to the philosophy of Russian Constructivism around 1920, and to the first clear perception, by Naum Gabo, of the unity of all visible forms and of the existence of aesthetic ones only in accordance with physical and



Three-dimensional trajectories of particles near a Kerr black hole
(*Calculations by V. Bellezza and V. Ferrari, drawing by M. Sacripanti*).

mathematical laws.

In the more recent context, characterized towards the late seventies by strong neo-expressionist and subjectivistic artistic movements, or neo-manner-ist re-evaluation of art from the past, interaction with science has meant above all the adoption and use of advanced technologies, the so-called "computer art." However, the use of media totally different from the traditional ones can change only the visual perception of the image and produce only a technical updating of the communication without necessarily yielding a new artistic message. On the other hand a "snapshot" which is new in concept and ichonography can also be expressed through the use of traditional and experimented techniques. Its very novelty may be expressed through the use of modules of different sizes and composition: namely in the form of a 20cm silver object, as in 1985, or in that of a 50cm bronze one, or in steel tubes, like the $340\times470\times260\text{cm}^3$ structure which was shown at the Venice Biennial Exhibition of 1986.

In the silence of his studio the artist finds his knowing craftsmanship, in making the moulds to be forged into metal and in his attempts to achieve the right shape of the torsions which express the intuition of their artistic value, with the light and opacity of the metal. With his mind, he tries not to betray the accuracy promised to the measurements of the curvatures and strives to make them coincide with his own geometric dream.

The discovery of a form which is not an invention, but bears the simple beauty and the perfection of an archetype existing in nature, leads one to re-experience aesthetically the same emotion that must have been felt by whoever discovered it first.

—English translation by Susanna Hirsch

TEST, sculpture by A. Pierelli, photo by S. Takahashi.

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Typeset with LaTeX by Bob Jantzen.

ICRANet

International Center for Relativistic Astrophysics Network

Headquarters: P.zza della Repubblica, 10 - 65122 Pescara
Tel.: (+39) 085 23054200 – Fax: (+39) 085 4219252; C.F.: 91080720682
Internet: http://www.icranet.org; e-mail: ruffini@icra.it; secretariat@icranet.org

ICRANET promotes international scientific cooperation and undertakes research in the field of Relativistic Astrophysics. Its activities are:

- development of scientific research;
- teaching at doctorate and post-doctorate level;
- long-term and short-term scientific training;
- organization of workshops and scientific meetings;
- arrangement of exchange programs for scientists and associates;
- development of new standards of electronic communication among the Research Centers;
- establishment of integrated data banks for all celestial bodies in all observable wave bands;
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GERBERTVS 2021

12 Maggio 2021 - 16:00-18:00
Meeting online

Scientific Rationale
Press Release

Astrofisica e nuove tecnologie

chiediamo ad affermati ricercatori, studenti universitari e professori quale siano le opportunità offerte in informatica, elettronica, automazione-robotica, e costruzioni ambiente e territorio in relazione al mondo dell'astronomia osservativa e/o dell'astrofisica teorica.
Verrà anche presentato il volume n. 14 di Gerbertus (2021)

intervengono

Saluti istituzionali
Prof. Remo Ruffini (Direttore di ICRANet)
Prof. Cosimo Palagiano (Accademia dei Lincei)

- Francesco Berrilli (Tor Vergata e Accademia dei Lincei, fisico solare)
- Paolo Ochner (Osservatorio Astrofisico di Asiago e Università di Padova, astronomo)
- Daniele Impellizzeri (ITA G. Garibaldi, IT specialist)
  Presentazione
- Paolo De Vincenzi (Sapienza, Fisica, studente)
  Studio sulla Fotoluminescenza delle Perovskiti Ibride
- Andrea Brucato (Sapienza, Fisica, studente)
  L'informatica nello studio dei fenomeni
- Fabio Zaccagnini (Sapienza, Ingegneria, studente)
  L'informatica nella scuola
- Lorenzo Ricciardi (Roma Tre, Informatica, studente)
  Il ruolo dell'informatica in astronomia
- Paola Spera (IIS Caffè, docente CAT)
  La stazione totale
- Giuseppe Cultrera (IIS Caffè, docente CAT)
  Campagna di rilievo per la meridiana di Santa Maria degli Angeli
- Runa Briguglio (INAF-Osservatorio Astrofisico di Arcetri)
- Federico Manzini (Stazione Astronomica IAU A12)
  Commento all'edizione digitale de Lo Scontro della Cometa (G. Artom, 1910)

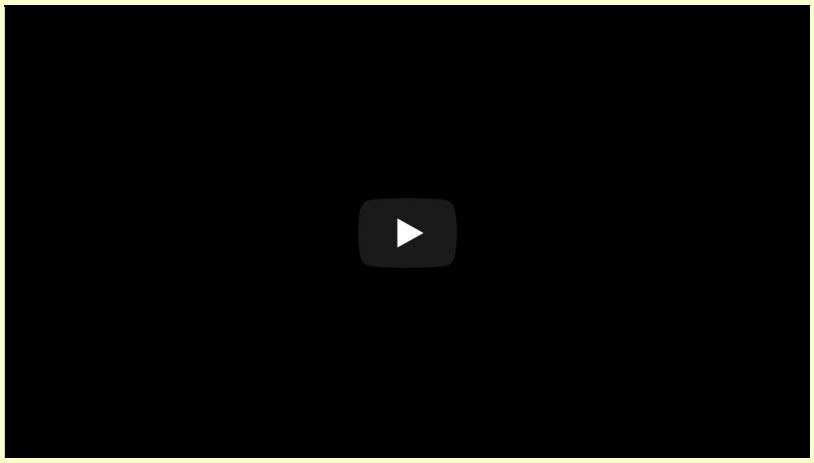
coordina

Costantino Sigismondi (prof.sigismondi@icra.it)
GERBERTVS 2021

Gerberto d'Aurillac (938 ca.-12.5.1003) fu monaco benedettino nella sua città d'origine in Francia, approfondì la matematica e l'astronomia a Vic in Catalogna, e fu conosciuto per la musica già dal papa Giovanni XIII nel 971 a Roma. Da lì partì per Reims dove fu docente alla scuola cattedrale e segretario dell'arcivescovo Adalberone fino alla sua

morte. Fu eletto vescovo di Reims nel 991, dopo la deposizione di Arnolfo, che il papa non riconobbe valida, e nel 995 si ritirò a Saasbach presso il giovane imperatore Ottone III, di cui era precettore. Ha scritto trattati sulle Canne d'Organo (980) sull'Astrolabio, sull'Abaco, introdusse le cifre indoarabe (983, Carme Figurato a Ottone II), sul De Rationali et ratione uti (997 a Ottone III) e il suo Epistolario è il più ricco pervenutoci dal X secolo. Nel 998 il papa Gregorio V lo nominò vescovo di Ravenna, e il 9 aprile 999 nel giorno di Pasqua fu incoronato Papa a Roma "da R in R in R" e prese il nome di Silvestro II. Una leggenda attribuisce a Gerberto, considerato l'uomo più dotto del suo tempo,pure la costruzione di un automa a logica binaria.

La storia dei precedenti meeting, dal 2003, è su http://www.icra.it/gerbertus



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17TH ITALIAN-KOREAN SYMPOSIUM FOR RELATIVISTIC ASTROPHYSICS

AUGUST 02 (MON), 2021 ~ AUGUST 06 (FRI), 2021

ONLINE BY CQUEST OF SOGANG UNIVERSITY
OFFLINE AT KUNSAN NATIONAL UNIVERSITY
(DEPENDING ON COVID19 SITUATION)

Celebrating the 50th Anniversary of "Introducing the Black Hole" and the Black Hole Mass-Energy Formula

IOC

REMO RUFFINI (ICRA-SAPIENZA UNIVERSITY ROME, ICRANET)
RONG-GEN CAI (ITP, CHINA)
PISIN CHEN (LECOSPA, NATIONAL TAIWAN UNIVERSITY)
MISAO SASAKI (IPMU, JAPAN)
JUN LUO *(SUN YAT-SEN UNIVERSITY, TO BE CONFIRMED)
SANG PYO KIM (KUNSAN NATIONAL UNIVERSITY)
BUM-HOON LEE (CQUEST, SOGANG UNIVERSITY, CHAIR)
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Day1(Mon,August 2nd):

Opening Ceremony(16:00~16:15)	**Chair: Sang Pyo Kim ,Kunsan National U (김상표, 군산대)**
Welcoming Address	**Byeong-Sun Kwak (President, Kunsan National U)**
Congratulatory Address	**Federico Failla (Ambassador, Italian Embassy)**
Italy-Korea Symposium Overview	**Remo Ruffini (Director, ICRANet/ICRA)**

Timeline **Speaker and Title**

Chair: Sang Pyo Kim, Kunsan National U (김상표, 군산대)

16:15-16:55 **Remo.Ruffini, ICRA-Sapienza University Rome/ICRANet (https://drive.google.com/file/d/1HA6AdwS2qb1jA9kYNxCKacWNQINpsARU/view?usp=sharing)**
The birth and raise of Relativistic Astrophysics

16:55-17:15 Break

Chair: Hyun Kyu Lee, Hanyang U (이현규, 한양대)

17:15-17:35 **Dong-Hoon Kim, Seoul National University (김동훈, 서울대)**
Pulsar radio emission with effects of gravitation and rotation

17:35-17:55 **Lang Liu, Institute of Theoretical Physics, China (https://drive.google.com/file/d/1I6L8RmbE7cwSSPeL6nCOhBFX3DlBYnl7/view?usp=sharing)**
Gravitational and Electromagnetic Radiation from Binary Black Holes with Electric and Magnetic Charges

17:55-18:15 **Chen-Te Ma, APCTP (https://drive.google.com/file/d/1R_W1ph9flOSlcLvTa85vq1CvFEbIOMsM/view?usp=sharing)**
Quantum correction of the Wilson line and entanglement entropy in the pure AdS_3 Einstein gravity theory

18:15-18:30 Break

18:30-19:00 **Daniele Gregoris, Jiangsu University of Science and Technology (https://drive.google.com/file/d/12OtJ63mMQXe4r5-qI5krKsT0nk93kG64/view?usp=sharing)**
Cosmology with interactions in the dark sector: qualitative dynamics, singularities and applications

Day2(Tue,August 3rd):

Timeline **Speaker and Title**

Chair: Daniele Gregoris, Jiangsu University of Science and Technology

16:00-16:30 **Soroush Shakeri, ICRANet-Isfahan, Isfahan University of Technology (IUT) (https://drive.google.com/file/d/1p7XiH9evqCoB1Z2MSP63x6V1F-Onjgkt/view?usp=sharing)**
The Role of Sterile Neutrinos in Cosmology and recent anomalies in Dark Matter Searches

16:30-17:00 **She-Sheng Xue, ICRANet, Physics Department, Sapienza University of Rome**
joint talk with Soroush Shakeri

17:00-17:15 Break

Chair: Bogeun Gwak, Dongguk U (곽보근, 동국대)

17:15-17:35 **Mu-In Park, Sogang U (박무인, 서강대) (https://drive.google.com/file/d/1ea2sYqcJIzr4ZYZruI6YHv3ABypQPPlb/view?usp=sharing)**
Tests of Standard Cosmology in Horava-Lifshitz-DeWitt Gravity

17:35-17:55 **Lu Yin, Sogang U (루인, 서강대) (https://drive.google.com/file/d/18y-_hWi6Hku6L8UM1T69FoiDziBWPFCe/view?usp=sharing)**
Gravitational waves from the vacuum decay with eLISA

17:55-18:15 **Chan Park, NIMS (박찬, 국가수리과학연구소) (https://drive.google.com/file/d/1enhE8RDKraRC89JM6v3uDswL9oyYqqeK/view?usp=sharing)**
Extending the Observational Frequency Range for Gravitational Waves in a Pulsar Timing Array

18:15-18:30 Break

18:30-18:50 **Chang-Hwan Lee, Pusan National University (이창환, 부산대) (https://drive.google.com/file/d/1hmcVh9Wb8Fk-oxVDzk8Vn87tMsjMfEuu/view?usp=sharing)**
Neutron Star Properties from Low-Mass X-ray Binary

18:50-19:15 **Eoin O Colgain, Sogang U (에오인 콜게인, 서강대) (https://drive.google.com/file/d/1SjEiSx12VIlATn4polvZ4EKDw4QTdfo6/view?usp=sharing)**
Observations on the Cosmological Principle

Day3(Wed,August 4th):

Timeline **Speaker and Title**

Chair: Soroush Shakeri, ICRANet-Isfahan, Isfahan University of Technology (IUT)

16:00-16:30 **Rahim Moradi, ICRANet (https://drive.google.com/file/d/1omNqvrKBUYmgGrdr2pQlIjOuDBV53-zg/view?usp=sharing)**
Broad line SNe-Ibc in GRBs, and Binary Driven Hypernova model

16:30-17:00 **Carlos Raul Arguelles, ICRANet (https://docs.google.com/presentation/d/1r8I0doKhOefl5zpCXDO_Z-naRwsMioV-/edit?usp=sharing&ouid=112416006424419134152&rtpof=true&sd=true)**
Fermionic dark matter profiles

17:00-17:15 Break

Chair: Wontae Kim, Sogang U (김원태, 서강대)

17:15-17:35 **Wonwoo Lee, Sogang U (이원우, 서강대) (https://drive.google.com/file/d/1OdeJeaiD-**

7I4eq5BlJHzrdpRP7i6nBa2/view?usp=sharing)
Astrophysical applications of rotating black holes with anisotropic matter field
17:35-17:55 **Dong-han Yeom, Pusan National University (염동한, 부산대)** **(https://drive.google.com/file/d/179GjFASAtqnPlriOtTdH_B-5qTr0yAKw/view?usp=sharing)**
Quantum boundary condition inside a black hole
17:55-18:15 **Jin Young Kim, Kunsan National University (김진영, 군산대)** **(https://drive.google.com/file/d/1Q0UdfDVplK1ToStUWvbXiH3rK6VCQ0kh/view?usp=sharing)**
Deflection of light in Born-Infeld electrodynamics

18:15-18:30 Break

18:30-20:30 **Banquet**

Day4(Thur,August 5th):

Timeline	Speaker and Title
	Chair: Jorge Rueda, ICRA/ICRANet
15:30-16:00	**Pisin Chen(National Taiwan University & Stanford University)** Gravitaional synchrotron radiation from storage rings
16:00-16:30	**Maria Giovanna Dainotti, ICRANet** The 2D L-T correlation and the 3D fundamental plane in multiwavelengths
16:30-17:00	**Liang Li, ICRANet** Constrainng the Type of Central Engine of GRBs with Swift Data
17:00-17:15	Break
	Chair: Chang-Hwan Lee, Pusan National University (이창환, 부산대)
17:15-17:35	**Hochoel Lee, Sogang U (이호철, 서강대)** **(https://drive.google.com/file/d/1Fhq1cO1TFzeFGCcp_yjdiFkKwi25MEGg/view?usp=sharing)** Hairy Black Hole Solutions in Dilatonic Einstein-Gauss-Bonnet Theory
17:35-17:55	**Myeonghwan Oh, Kyungpook National University (오명환, 경북대)** **(https://drive.google.com/file/d/1pEMZ9Q_ATqkm0Bvopt5m7jETMWx2sZ8U/view?usp=sharing)** Cosmic rays produced by magnetic Penrose process in Sgr A*
17:55-18:15	**Davood Rafiel Karkevandi, Isfahan University of Technology (IUT)** **(https://drive.google.com/file/d/1k148g5u7Ya1qW1ErtCWqE4E26Llj121-/view?usp=sharing)** Probing Bosonic Dark Matter inside NS by the Tidal defomability

Day5(Fri,August 6th):

Timeline	Speaker and Title
	Chair: Rahim Moradi, ICRANet
15:30-16:00	**Kuantay Boshkayev** Accretion disc luminosity for black holes surrounded by dark matter
16:00-16:30	**Narek Sahakyan, ICRANet** Multiwavelength and Multimessenger view of blazars
16:30-17:00	**Jorge Rueda, ICRA/ICRANet** Synchrotron emission in GRB afterglows from binary-driven hypernovae and compact star binary mergers
17:00-17:15	Break
	Chair: Hyung Won Lee, Inje University (이형원, 인제대)
17:15-17:35	**Sung-Won Kim, Ewha Womans University (김성원, 이화여대)** **(https://drive.google.com/file/d/1UonQKX2u2aIifIn7vNrY5bwlaVkMv0Aj/view?usp=sharing)** Gravitational Waves Generated by a Slowly Rotating Wormhole
17:35-17:55	**Mahdis Ghodrati, APCTP** **(https://drive.google.com/file/d/1fRS38WiTz4v9WNynZN0WOvVAej9iqHQE/view?usp=sharing)** Phase transitions and curvature invariants of the Massive Banados-Teitelboim-Zanelli black holes in massive gravity theory
17:55-18:15	**Sang Pyo Kim, Kunsan National U (김상표, 군산대)** Magnetars as Laboratory for Strong Field QED
Closing(18:15~18:30)	**Stefano Scopel, Sogang U (스테파노 스코펠, 서강대)**

Presentations are planned to be published by the proceedings through the Journal of the Korean Physical Society (JKPS).
Submission deadline: October 31, 2021

file

Ateneo Pontificio *Regina Apostolorum*

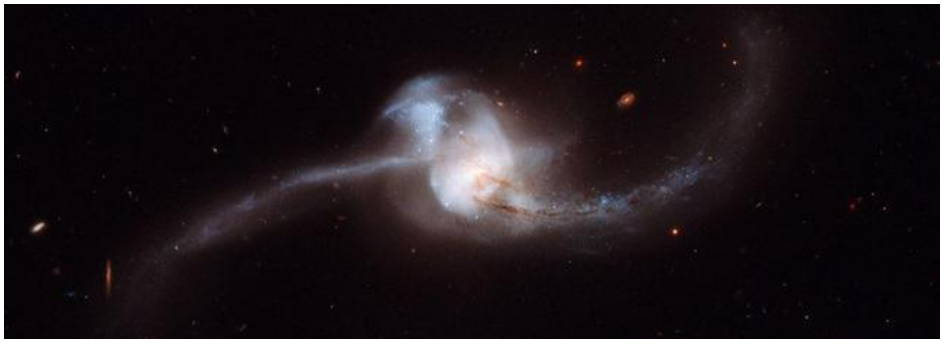
Istituto Scienza e Fede

Master in Scienza e Fede

ISFO1001 Storia dell'Astronomia

Prof. Costantino Sigismondi

ICRA International Center for Relativistic Astrophysics



***Scopo del corso*:** le tappe della storia dell'Astronomia sono esaminate in modo organico per fornire una panoramica delle problematiche scientifiche fondamentali, legati alle strategie e agli strumenti di misura, all'interpretazione tramite modelli e alla previsione di fenomeni.

***Struttura del corso*:** Astronomia Egizia e dei Caldei; Archimede; Ipparco; Tolomeo, teoria solare e lunare; Tolomeo, teoria planetaria; Astronomia Medievale Cristiana; Astronomia Araba; Gerbert d'Aurillac; Sacrobosco; Regiomontano; Copernico; Keplero; Galileo; Cassini; Astronomia a Greenwich; Newton; Astrometria nel XIX secolo; Astronomia negli USA; Astronomia e cosmologia nel XX secolo.

Escursioni: Sono previste escursioni in luoghi di interesse storico scientifico a Roma: S. Maria degli Angeli, Collegio Romano e Meridiana di Augusto, Meridiana a San Pietro.

Osservazioni: Transiti al meridiano del Sole e della Luna. Transito di Mercurio. Fotometria dei tramonti del Sole, e studio della trasmittanza atmosferica presso l'orizzonte.

Testi di riferimento: C. Sigismondi (a cura di), *La Sfera. Da Gerberto al Sacrobosco*, UPRA, Roma 2008; C. Sigismondi (a cura di), *Meridiani e Longitudini a Roma*, Sapienza Università di Roma, 2006; C. Sigismondi, *Lo Gnomone Clementino*, Roma 2009; C. Sigismondi, *Il diametro solare, istruzioni per l'uso*, Roma 2021.

Il corso si svolgerà on-line (Zoom/YouTube), in modalità intensiva,
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22 (16:00-18:30); **24** (16:00-18:30); **25** (16:00-18:30); **26** (17:00-19:30);
27 (appuntamento alle 10:00 am a Piazza san Pietro, fino alle 12:30)

Ateneo Pontificio Regina Apostolorum

Via degli Aldobrandeschi, 190 - 00163 Roma

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UNDER THE AEGIS OF
H.E. MOHAMMAD ALI ZOLFIGOL, MINISTER OF SCIENCE, RESEARCH AND TECHNOLOGY (MSRT), ISLAMIC REPUBLIC OF IRAN

ICRANet-Isfahan Astronomy Meeting

ICRANet

Isfahan University of Technology

3-5 NOVEMBRE 2021 VIRTUAL MEETING

FROM THE ANCIENT PERSIAN ASTRONOMY TO RECENT DEVELOPMENTS IN THEORETICAL AND EXPERIMENTAL PHYSICS, ASTROPHYSICS AND GENERAL RELATIVITY

With a Workshop on Data Science in Relativistic Astorphysic

https://indico.icranet.org/event/2/

50th Anniversary of "Introducing the Black Hole"

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Wang Yu, ICRANet, Italy
M. H. Zhollideh Haghighi, IPM, KNTU, Iran

INVITED SPEAKERS

S. Abbassi, Ferdowsi Univ., Iran
Y. Aimuratov, Fesenkov Inst., Kazakhstan
L. Amati, INAF-OAS Bologna, Italy
C. Arguelles, Univ. La Plata, Argentina
L. Becerra, PUC, Chile
K. Boshkayev, Al-Farabi Univ., Kazakhstan
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M. H. Zhollideh Haghighi, IPM and KNTU, Iran

ICRANet-ISFAHAN Astronomy Meeting

Wednesday, 3 November 2021 - Friday, 5 November 2021

Programme

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Wednesday 03 November 2021

Opening ceremony: The Welcoming Speeches : The Minister of MSRT, Prof. ZulfiGul and The IUT President, Prof. S. M. Abtahi (10:00-10:30)

How the modern astronomy was introduced into Iranian universities (10:30-11:00)

- **Presenter: Prof. SOBOUTI, Yousef (IASBS-Iran)**

Celebrating the 50th anniversary of "Introducing the Black Hole" (11:00-11:30)

- **Presenter: Prof. RUFFINI, Remo**

Iranian National Observatory; status and vision (11:30-12:00)

- **Presenter: Prof. KHOSROSHAHI, Habib (IPM, Iran)**
  Iranian National Observatory (INO) is located on Mt Gargash at 3600m covering a gap in the longitude distribution of modern mid-size telescopes. The INO project is now in its final stage of completion and is approaching the first light. Major milestones including the civil construction, installation of the dome, manufacturing of the 3.4m optical telescope and installation of the telescope at the site have been completed. The telescope is going through engineering tests aimed at the commissioning of the pointing and tracking. A suite of instruments has been planned, taking advantage of a sub-arcsecond seeing and the longitude, including a high-resolution imaging camera and a spectrograph with the ability to switch between the instruments in response to transient events. INO offers a platform for regional and international collaborations in astronomy and cosmology.

The Huntsman Telescope - a Canon lens array designed for low surface brightness imaging (12:00-12:30)

- **Presenter: Prof. SPITLER, Lee (Macquarie University, Australia)**
  In this talk I give an update about the Huntsman Telescope, a new astronomy observing system that makes use of an array of 10 Canon lenses to take images of extremely faint astronomical sources. Inspired by the Dragonfly Telephoto Array, the system is designed to better understand galaxy evolution through the study of low surface brightness structures. I'll describe the science motivation, show preliminary data, and give an update on how the commissioning of the system at Siding Spring Observatory, Australia. I'll also review other initiatives with Huntsman, including an sub-second transient detection mode. https://huntsman.space/

Break (12:30-12:50)

Supenovae (SN) - Gamma Ray Burst (GRB) Connection (12:50-13:20)

- **Presenter: Prof. DELLA VALLE, Massimo ((apodimonte Astronomical Observatory - INAF, Naples, Italy))**

Gamma-ray bursts in the optical domain (13:20-13:50)

- **Presenter: Prof. IZZO, Luca (University of copenhagen, Demark)**

Origin of High-energy Galactic Cosmic Rays: Implication from Recent Ultrahigh-energy Gamma-ray Observations (15:30-16:00)

- **Presenter: Prof. LIU, Ruoyu (Nanjing University | NJU, China)**
  Observations of gamma-ray emission with energy above 100 TeV is a useful probe of the long-sought PeV cosmic-ray sources. In this talk, I will briefly review recent observations by the LHAASO, HAWC and ASgamma experiments on sources and diffusive emission with energy above 100 TeV, and then discuss their implications for the origin of high-energy Galactic cosmic rays.

Multiwavelength and Multimessenger view of blazars (16:00-16:30)

- **Presenter: Prof. SAHAKYAN, Narek (ICRANet-Armenia)**
  I will discuss the recent progress in multiwavelength and multimessenger observations of blazars and the current status of the theoretical models applied to model their emission. Blazars, the most extreme subclass of AGN having jets that move relativistically towards the observer, are characterized by highly variable non-thermal emission across the entire electromagnetic spectrum, from radio up to very high energy gamma-ray bands. The emission

properties of blazars in the spectral and time domains will be presented and discussed using the data collected from their observations in optical/UV, X-ray, and gamma-ray bands. In addition, the recent progress in the observations of very high-energy neutrinos from blazars will be discussed.

Cosmology with Gamma-Ray Burst (16:30-17:00)

- Presenter: Prof. AMATI , Lorenzo

Gamma-Ray Bursts constitute one of the most fascinating and relevant phenomena in modern science, with strong implications for several fields of astrophysics, cosmology and fundamental physics. In this review, I will focus on the perspective key-role of GRBs for cosmology. Indeed, the huge luminosity, the redshift distribution extending at least up to z~10 and the association with the explosive death of very massive stars make long GRBs (i.e., those lasting up to a few minutes) potentially extremely powerful probes for
shedding light on main open issues in our understanding of the early Universe: star formation rate evolution up to the first generation of stars (pop-III), cosmic reionization, luminosity function and metallicity evolution of primordial galaxies up to the "cosmic dawn". At the same time, interesting correlations between luminosity / radiated energy and spectral photon peak energy are subject of intensive investigations for "standardizing" GRBs and using them for measuring cosmological parameters, investigating the nature and evolution of "dark energy" and testing non-standard cosmological models. I will also report on the status, concepts and expected performances of space mission projects aiming at fully exploiting these unique potentialities of the GRB phenomenon, thus providing an ideal sinergy with the large e.m. facilities of the future like LSST, ELT, TMT, SKA, CTA, ATHENA

Break (17:00-17:20)

Black hole hyperaccretion disks and gamma-ray bursts (17:20-17:50)

- Presenter: Prof. ABBASSI, Shahram (Ferdowsi University of Mashhad)

Gamma-ray bursts (GRBs) are the most luminous explosions in the Universe, and their origin and mechanism are the focus of intense research and debate. Black hole hyperaccretion model is one of the plausible candidates for the central engine of gamma-ray bursts and their activity is supposed to result in the complicated explosion phenomena including gamma-ray bursts, gravitational waves, and their electromagnetic counterparts. In the inner regions of such disks, photons are totally trapped due to high density and temperature. Getting cool through neutrinos and antineutrinos efficiently, these accretion disks are also called Neutrino Dominated Accretion Flows (NDAFs). Moreover, the high magnetic field (10^15−16G) and large density (10^10g cm−3) can be considered as the two important physical features of these disks, and as a result, self-gravity and gravitational instability might be of a crucial role in these dense hyperaccretion flows. As well, the magnetic field is proposed to be of considerable importance via both large and small scale impacts. After providing an introduction to the GRB’s and the candidates of their central engines, we focus on these two factors (self-gravity and magnetic field) to probe their potential effects on the hyperaccretion disk’s structure, in addition to their subsequent impacts on the GRB’s spectral features. In other words, we apply these two features to provide an explanation for the prompt Gamma-ray emission with its highly variable structure in the early time, and the electromagnetic afterglow emission associated with the late time activity of the GRB’s central engine.

SPH simulations of the Induced Gravitational Collapse (17:50-18:20)

- Presenter: Prof. BECERRA, Laura (PUC, Chile)

The Induced Gravitational Collapse (IGC) paradigm points to a binary origin for the long-duration gamma-ray burst (GRBs) associated with supernovae (SN). In this one, a carbon-oxygen core (COcore) explodes in a Type Ib/c SN in presence of a close neutron star (NS) companion. The SN triggers a hypercritical accretion into the NS and depending on the initial binary parameters, two outcomes are possible given place to two families of long GRBs: binary-driven hypernova (BdHNe), where the NS reaches its critical mass, and collapses to a black hole (BH), emitting a GRB; and x-ray flashes (XRFs) where the hypercritical accretion onto the NS is not sufficient to induce its gravitational collapse. We perform three-dimensional (3D) numerical simulations of the IGC paradigm with the smoothed particle hydrodynamics (SPH) technique. We determine whether the star gravitational collapse is possible and assess if the binary holds gravitationally bound or it becomes unbound by the SN explosion.

Az Zarreh Taa Aaftaab: The Role of General Relativity in the Structure of Elementary Particles of Matter

(18:20-18:50)

- Presenter: Prof. TAHVILDAR-ZADE, Shadi (Rutgers, USA)

It was a largely unfulfilled dream of Einstein to arrive at a quantum theory of atomistic matter that included electrodynamic phenomena, and one in which the principles of general relativity would reign supreme. Even though he is generally considered to have failed in this quest, his unifying vision remains a powerful one to this date. In this talk we explore some of the ways in which Einstein's dream may one day be realized, including (1) a

general-relativity-based formulation of the joint evolution of classical fields together with point-particles that are sources of those fields, (2) a well-motivated deformation of classical nonlinear theories to quantum theories in which the motion of particles is guided by linear waves on particle configuration space, and (3) ring-like particles inspired by general relativity and a possible resolution of the dark matter puzzle.

Thursday 04 November 2021

"Science is undermined every time we let ideology substitute for actual truth" - Ethan Siegel (10:00-10:30)

- Presenter: Prof. KERR, Roy Patrick (University of Canterbury, Christchurch, New Zealand and ICRANet, Italy)
I will discuss The following ideas that have reached dogma status,
1) The universe is approximately conformally flat and isotropic,
2) Black holes have singularities, and evaporate,
3) Entropy can be generalised to GR.

Angular Momentum to a Distant Observer (10:30-11:00)

- Presenter: Prof. YAU, Shing-Tung (Harvard-USA)
The notion of angular momentum in general relativity has been a subtle issue since the 1960's, due to the discovery of ``supertranslation ambiguity'': the angular momentums recorded by two distant observers of the same system may not be the same. In this talk, I shall show how mathematical theory identifies a correction term, and leads to a new definition of angular momentum that is free of any supertranslation ambiguity. This is based on joint work with Po-Ning Chen, Jordan Keller, Mu-Tao Wang, and Ye-Kai Wang

Gravitomagnetic interaction of a Kerr black hole with a magnetic field as the source of the high-energy radiation of gamma-ray bursts (11:00-11:30)

- Presenter: Prof. RUEDA, Jorge (ICRANet)
It is shown how the gravitomagnetic interaction of a Kerr black hole (BH) with a surrounding magnetic field induces an electric field able to accelerate surrounding charged particles to ultra-relativistic energies. Along the BH rotation axis, electrons/protons can reach even thousands of PeV leading to ultrahigh-energy cosmic rays (UHECRs) from stellar-mass BHs in long gamma-ray bursts (GRBs) and from supermassive BHs in active galactic nuclei (AGN). At off-axis latitudes around the BH vicinity, particles are accelerated to hundreds of GeV, and by synchrotron radiation emit high-energy GeV photons. Such a process occurs at all latitudes within 60 degrees of the polar axis. The theoretical framework describing these acceleration and radiation processes, how they extract the rotational energy of the Kerr BH, as well as the consequences for the astrophysics of GRBs are outlined.

Break (11:30-11:50)

New high precision tests of General Relativity (11:50-12:20)

- Presenter: Prof. LÄMMERZAHL, Claus (ZARM, University of Bremen)

Exploring gravitation in the inner Solar System: Giuseppe Colombo, Mercury and the BepiColombo mission (12:20-12:50)

- Presenter: Prof. PERON , Roberto (National Institute of Astrophysics (INA) - IAPS, Italy)
The Solar System is an arena where multiple scientific paths intersect and interact. Seen from the point of view of fundamental physics, it is a test bench where the machinery of gravitation can be more directly accessed, albeit in its "weak-field" appearance. It is particularly the case of planet Mercury, due to its relative proximity to the Sun. Fundamental contributions to its exploration came from an Italian scientist, Giuseppe "Bepi" Colombo, who in particular proposed an effective trajectory strategy for the Mariner 10 probe. After this pioneering mission and the more recent MESSENGER one, it is now the turn of an European mission, BepiColombo, to further enlarge our knowledge of Mercury and the near-Sun environment. The mission and its scientific objectives will be presented, with particular regard to the planned tests of general relativity theory and to Mercury geodesy and geophysics.

The role of campfires in the heating of solar coronal plasma observed by Solar Orbiter and Solar Dynamics Observatory (12:50-13:20)

- Presenter: Prof. SAFARI, Hossein

Uncovering the Energetic of the Interstellar and the Intergalactic Medium with the SKA (13:20-13:50)

- Presenter: Prof. TABATABAEI, Fatemeh (IPM)
Investigating the physics and energetic of the medium where galactic structures, on various scales, are formed is the most fundamental step to understand the formation and evolution of galaxies. Modern galaxy evolution models

suggest gas accretion from the intergalactic medium or from cosmic filaments as a mechanism to maintain star formation and AGNs. Through gas heating and/or gas removal, these models also propose supernova feedback and AGN feedback as mechanisms to quench massive star formation. Observational studies however have not reached to a conclusive result, showing that feedback can, in some cases, trigger star formation, leaving the issue as an open challenge. It seems that we have missed some basic concepts about the formation of structures in the ISM and the IGM: What are physical parameters/agents governing the structure formation on various scales? and what is their relative importance? How does the ISM/IGM energy balance change over the cosmic time? Addressing these, it is vital to obtain a more complete picture of the ISM & IGM than what is known currently. The advent of the SKA and its new instrumental capabilities tracing the most energetic ISM components combined with the ground-breaking results from the ALMA, HST, VLT/MUSE, etc has opened a new window shedding light on the issue. The SKA's sensitive radio continuum observations will trace high-energy particles and magnetic fields not only in star forming regions and AGNs, but also in more quiescent regions in molecular clouds and diffuse ISM, enabling us to study the role of magnetic fields/cosmic rays in structure and star formation. On larger scales, these observations will allow us to address what determines the accretion rate from the IGM. Sensitive radio continuum observations on large scales may also bring constrains on the entity of the dark matter mapped by the HST and DECam.

Universality of Peaking Time of Supernovae in Association with Gamma-Ray Bursts (15:00-15:30)

- Presenter: Prof. AIMURATOV, Yerlan (Fesenkov Inst., Kazakhstan)

We discuss on the recent progress in Gamma-Ray Bursts - Supernova connection and make inferences coming from the universality of peaking time of Supernovae in this association.

Self-Similarities and Power-laws in the Time-resolved Spectra of GRB 190114C, 130427A, 160509A, and 160625B (15:30-16:00)

- Presenter: Prof. LI, Liang (ICRANet)

Context. A new time-resolved spectral analysis performed on GRB 190114C has allowed to identify in its prompt emission observed by Fermi-GBM three specific Episodes predicted to occur in BdHNe I. Episode 1, which includes the "SN-rise" with a characteristic cutoff power-law and blackbody spectra; the Episode 2, initiated by the moment of formation of the BH, temporally coincident with the onset of the GeV emission and the onset of the ultra-relativistic prompt emission (UPE) phase a characterized by cutoff power- law and blackbody spectra; Episode 3, the "cavity", with its characteristic featureless spectrum recently described in a companion paper (Ruffini et al. 2019b). An extreme time-resolved analysis performed on an iterative process in a sequence of ever decreasing time interval, has allowed to find self-similar structures and power-laws in the UPE of GRB 190114C; see e.g., the companion paper (Ruffini et al. 2019a). This has led to the first evidence for the identification of a discrete quantized emission in the GeV and MeV emission presented in the companion papers (Ruffini et al. 2018b; Rueda & Ruffini 2019).
Aims. To identify and verify the BdHNe I properties in the additional sources GRB 160509A, GRB 160625B and GRB 1340427A, and compare and contrast the results with the ones of a BdHN II source GRB 180728A (Wang et al. 2019b). We have also identified in all four sources, following the analysis GRB 130427A in the companion paper (Ruffini et al. 2018b), the GeV radiation during and following the UPE phase. Also in all the four sources, we describe the spectral properties of their afterglow emission, including the mass estimate of the νNS, following the results presented in the companion paper (Rueda et al. 2019).

Methods. In GRB 160509A and GRB 160625B, we have first identified the aforementioned three BdHN I Episodes. In the UPE phase, we have performed the time-resolved spectral analysis following the iterative process in a sequence of ever decreasing time intervals. We have also examined both the GeV radiation and the afterglow phases. The same procedure has been repeated in the case of GRB 130427A with the exception of the UPE phase, in view of a pile-up problem. The case of GRB 180728A, a BdHN II, has been used as a counterexample.

Results. The results of the spectral analysis have validated the common properties in all BdHNe I: the three Episodes as well as the self-similar structures and the associated power-laws in the UPE phase. The profound similarities of the results have made a significant step forward in the taxonomy of GRBs and in evidencing a standard composition of the BdHN I. This opens the opportunity of a vaster inquire of the astrophysical nature of their components in the population synthesis approach: e.g., the BH formation in all BdHN I occurs due to accretion of the SN ejecta in a tight binary system with a neutron star companion which reaches its critical mass, leading to the formation of the BH. The SN-rise in all five BdHNe are compare and contrasted.

Conclusions. The most far reaching discovery of self-similarities and power-laws here extensively confirmed, thanks also to the conclusions presented in the companion papers (Ruffini et al. 2018b, 2019a), leads to the existence of a discrete quantized repetitive polarized emission, both in the GeV and MeV observed by Fermi-GBM and Fermi-LAT, on a timescale as short as 10−14 s. These results open new paths in the discovery of fundamental physical laws.

Break (16:00-16:10)

Data Science in Relativistic Astrophysics - 1: Classification the stars using photometric optical data of SDSS (16:10-16:55)

- Presenter: Prof. ZHOLLIDEH HAGHIGHI, M. H. (IPM and KNTU, Iran)
Classification the stars using photometric optical data of SDSS

RR Lyrae variables are periodic variable stars, commonly found in globular clusters. They are used as standard candles to measure (extra) galactic distances, assisting with the cosmic distance ladder. They are pulsating horizontal branch stars of spectral class A or F, with a mass of around half the Sun's. They are thought to have shed mass during the red-giant branch phase and were once stars of similar or slightly less mass than the Sun, around 0.8 solar masses. In contemporary astronomy, a period-luminosity relation makes them good standard candles for relatively nearby targets, especially within the Milky Way and Local Group. They are also frequent subjects in the studies of globular clusters. We use the set of photometric observations of RR Lyrae stars in the SDSS as our data. The data set comes from SDSS Stripe 82, and combines the Stripe 82 standard stars, which represent observations of non-variable stars; and the RR Lyrae variables pulled from the same observations as the standard stars, and selected based on their variability using supplemental data. The sample is further constrained to a smaller region of the overall color–color space following ($0.7<u-g<1.35$, $-0.15 < g - r < 0.4$, $-0.15 < r - i < 0.22$, and $-0.21 < i - z < 0.25$). These selection criteria lead to a sample of 92,658 non-variable stars, and 483 RR Lyraes. Two features of this combined data set make it a good candidate for testing classification algorithms:

1- The RR Lyrae stars and main sequence stars occupy a very similar region in u, g, r, i, z color space.

2- The extreme imbalance between the number of sources and the number of background objects is typical of real-world astronomical studies, where it is often desirable to select rare events out of a large background. Such unbalanced data aptly illustrates the strengths and weaknesses of various classification methods.

Our goal is to characterize the relation between the features in the data and their classes and apply these classifications to a larger set of unlabeled data. In this hands-on session, participants will learn how to use machine learning algorithms in practice and classify observed stars from optical data. This session has two parts in the first part we try to classify objects by some well known conventional machine learning algorithms such as logistic regression and etc. In the second part we use Neural Network for our classification purposes.

Data Science in Relativistic Astrophysics, 2-Classification of astronomical objects and determining their redshift using spectroscopic optical data of SDSS (16:55-17:40)

- Presenter: Prof. MORADI, Rahim (ICRANet-Italy)
Classification of astronomical objects and determining their redshift using spectroscopic optical data of SDSS

Quasi-stellar radio source (Quasars) or quasi stellar objects (QSO) are high-luminosity active galactic nuclei (AGN) which are believed to be powered by accretion disks around supermassive black holes (SMBHs) with masses in the range of 1 million to 1 billion solar mass. Thanks to their high luminosity, quasars have been found to spread from redshift z~0 all the way back to z~7 when the universe was forming its first structures, namely the epoch of reionization. Therefore, study the high-redshift quasars can be taken into account as a powerful tool to study the cosmic history and structure formation in the early universe. Owing to their existence at redshifts ranging from z=0 to z~ 7, quasars provide a new possible standard candle, like type Ia supernovae, which can infer new cosmological constraints to study the evolution of the universe.

In this part, after introducing the methods to process and prepare the spectroscopic optical data of SDSS, we represent the architecture of a 1-dimensional convolutional neural network (CNN) to estimate the redshift of quasars in Sloan Digital Sky Survey IV (SDSS-IV) catalog from DR16 quasar-only (DR16Q) of eBOSS. We show how this CNN can be easily extended in order to classify stars, galaxies and quasars as well as prediction of their redshift. The CNN takes the flux of the quasars as an 1--dimensional array and their redshift as labels. Therefore, This CNN extract the spectroscopic features of SDSS data and predicts the redshift of quasars. We finally represent a similar CNN, but less efficient, which is already used by SDSS website to classify the quasars, stars and galaxies, as well as predict the redshift.

In this session, participants will learn how to process the SDSS spectral data in order to implement them in 1-dimensional CNN and observe the preliminary results.

Data Science in Relativistic Astrophysics, 3-More networks and more areas (17:40-18:25)

- Presenter: Prof. YU, Wang (ICRANet, Italy)
More networks and more areas

Based on the first two tutorials, we introduce more types of neural networks applied to more kinds of astronomical data.

In the above example of inferring redshift from SDSS data, we build simple but efficient 1D CNN networks and obtain accurate results. We further complicate the CNN network by introducing advanced structures such as Residual, Attention, etc., and applied the latest networks from the industry field to the same data to infer redshift, and to test whether the accuracy has improved.

Secondly, we make a brief introduction to gravitational wave and gamma-ray burst data, and transfer the above networks to the machine learning subjects of gravitational wave and gamma-ray burst. Astronomical data are nothing but temporal and spatial data, we hope this short tutorial can broaden the horizon and be able to build the network flexibly.

Friday 05 November 2021

The Light of the Moon: Ibn al-Haytham and Galileo (10:00-10:30)

- Presenter: Prof. MASOUMI HAMEDANI , Hossein (Iranian Institute of Philosophy, Iran)
In a treatise entitled On the Light of the Moon, the physicist and mathematician of the 10th-11th centuries Ibn al-Haytham proves that the Moon is not a polished body and that it does not reflect the light it receives from the Sun in the way a convex mirror does. Almost six centuries later, Galileo takes up the same problem in his famous Dialogues Concerning the Two Great World System. By a method which is somewhat different from that of Ibn al-Haytham, he arrives at a similar conclusion.
The aim of this article is to discuss the similarities and the differences of the two methods and the conclusions their authors draw from them.

Astronomy in Islamic World - a European perspective (10:30-11:00)

- Presenter: Prof. KERNER, Richard (Sorbonne Université, France)
Arab and Islamic Civilization emerged at the crossroads in a double sense, as a bridge between the Greco-Roman Antiquity and European Modernity in time, and as the junction between the declining Roman Empire and the still vigorous Indian and Persian civilizations in space. In this talk, we shall highlight the most important contributions of Islamic Polymaths to Mathematics and Astronomy, paving the way to the next stage of the development of science which occurred in the late Middle Ages in Europe.

Break (11:00-11:20)

Dark matter fermions: from linear to non-linear structure formation (11:20-11:50)

- Presenter: Prof. ARGUELLES, Carlos (ICRANet, Italy)
Relaxation mechanisms of collisionless self-gravitating systems of fermions in cosmology, can lead to equilibrium states which are stable, long-lived, and able to explain the dark matter (DM) halos in galaxies. The most general fermionic DM profile out of such a mechanism, develops a degenerate compact core which is surrounded by an extended halo. When applied to the Milky Way, it is demonstrated that the outer halo can explain the rotation curve of our Galaxy, while the central DM-core explains the dynamics of all the best resolved S-cluster stars orbiting SgrA *, without assuming a central black hole (BH). When such novel core-halo DM profiles are applied to larger galaxies, the dense DM core can reach the critical mass for gravitational collapse into a BH of □ 10^8 Mo. This result provides a new mechanism for supermassive BH formation in active galaxies directly from DM, leading to a paradigm shift in the understanding of galactic cores.

The dynamics of ultra-diffuse dwarf galaxies in MOND (11:50-12:20)

- Presenter: Prof. HAGHI , Hosein (ISABS-Iran)
In this talk, I will review the current state of research on the apparently dark matter-free ultra-diffuse dwarf galaxies, emphasizing what our research team has investigated in recent years. In particular, I will focus on galaxies NGC 1052-DF2 and NGC 1052-DF4 in the framework of MOND. Due to the non-linear Poisson equation in MOND, a dwarf galaxy has weaker self-gravity when in close proximity to a massive host. Using our analytic formulation and fully self-consistent live N-body models in MOND, I will show you how the dynamics of these galaxies are in good agreement with MOND prediction.

Probing the first instants of the universe with large scale structure (12:20-12:50)

- Presenter: Prof. STAHL, Clement (Strasbourg U., France)
In this talk, I will discuss the state of the art in the field of large scale structure for cosmology. I will in particular discuss the novel approach of effective field theory which allows to integrate out complicated small scales physics. I will entertain the possibility that it is now possible to propagate a primordial signal throughout cosmic history and detect it in future galaxy surveys, In this sense, large scale structures could be used to constrain primordial physics and thus push forward our fundamental understanding of our universe.

Shadows around at Sgr A* and M87* as a tool to test gravity theories (12:50-13:20)

- Presenter: Prof. ZAKHAROV, Alexander (BLTP, JINR, Dubna, Russia)
The shadow around the supermassive black hole in M87 was reconstructed in 2019 based on its observations with the Event Horizon Telescope in 2017. Recently polarization map for the M87* shadow was presented. We discuss opportunities to evaluate parameters of alternative theories of gravity with shadow observations, in particular, a tidal charge could be estimated from these observations.

Luminosity of accretion disks in compact objects with a quadrupole (15:00-15:30)

- Presenter: Prof. BOSHKAEV, Kuantay (Al-Farabi Kazakh National University, Almaty, Kazakhstan Nazarbayev University, Nur-Sultan, Kazakhstan)

We consider the circular motion of test particles in the gravitational field of a static and axially symmetric compact object described by the q metric. To this end, we calculate orbital parameters of test particles on accretion disks such as angular velocity, total energy, angular momentum, and radius of the innermost stable circular orbit as functions of the mass and quadrupole parameters of the source. The radiative flux, differential and spectral luminosity of the accretion disk, which are quantities that can be experimentally measured, are then explored in detail. The obtained results are compared with the corresponding ones for the Schwarzschild and Kerr black holes in order to establish whether black holes may be distinguished from the q metric via observations of the accretion disk's spectrum

Axion in Astrophysics (15:30-16:00)

- Presenter: Prof. CARENZA, Pierluca (Stockholm U., OKC, Sweden)

This is a review of the latest developments on axion astrophysics, with particular attention to the axion production in stellar environments and to the phenomenology of the axion-photon mixing on astrophysical scales.

Production of Thermal QCD Axions in the Early Universe (16:00-16:30)

- Presenter: Prof. HAJKARIM, Fazlollah (UNIPD-Italy)

We study the thermal production of axions over different scales especially around the QCD and electroweak phase transitions in the early universe. We focus on the most motivated axion models (KSVZ and DFSZ) and investigate how the thermal history can influence on the production rate of hot axion as dark radiation. This can lead to predictions for the future measurements of the cosmic microwave background by experiments like CMB-S4.

Concluding remarks (16:30-17:00)

- Presenter: Prof. SHAKERI, Soroush

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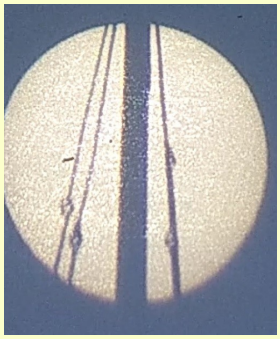
Public Events

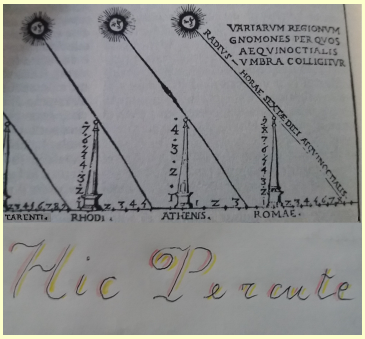
Eclissi Antartica e transiti meridiani

esperimenti di meccanica celeste e astrofisica

4 Dicembre 2021 - 10:00-11:00
Meeting online



Il Sole in proiezione al meridiano di san Pietro il 24 novembre 2021



Incisione del Cesariano (1521) di Vitruvio, De Architectura, Libro IX capitolo VII con la frase della leggenda su Gerberto e il tesoro di Augusto

Il Sole al meridiano di san Pietro poco prima dell'eclissi meridiana il 26 Novembre 2021

L'eclissi totale di Sole fornisce l'occasione di riconsiderare il diametro solare e le sue misure per confronto con le effemeridi con diametro standard.

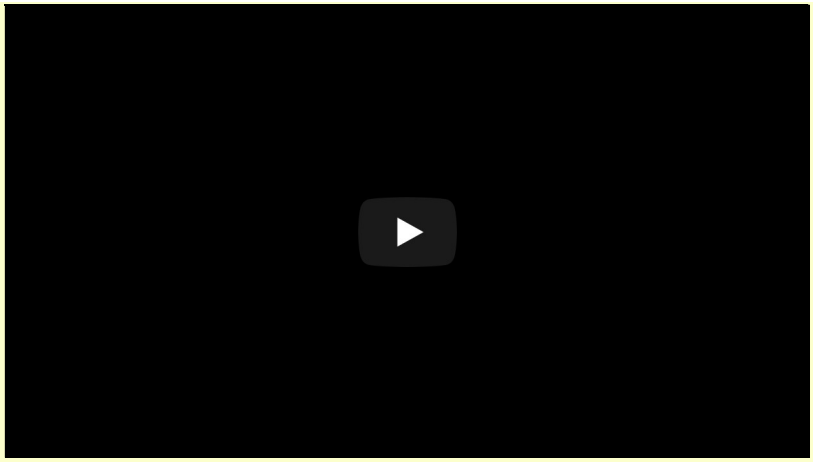
- consultazione delle effemeridi (NASA-Horizons, massimo e Luna Nuova)
- eclissi e timing, incertezza di misura e suo "peso" relativo all'eclissi
- transiti meridiani e timing (stesso discorso, ma con il contributo dell'atmosfera)
- primi risultati dall'obelisco-meridiana di san Pietro sui transiti e il diametro solare
- ingressi del Sole nello Scorpione e nel Sagittario 2021 a san Pietro con Sole e Stelle (preliminary results e calibrazione dello strumento)
- eclissi in Antartide e la doppia eclissi dell'anno 810 nella lettera di Dungal a Carlo Magno: Dungal a Carlo Magno doppia eclissi di Sole anno 810: (arxiv.org)

Ampio spazio per le domande

Costantino Sigismondi
Astronomia di posizione del Sole a san Pietro: gli ingressi nei segni zodiacali SCO SGR 2021 coi transiti meridiani

Video dell'eclissi commentato
e Riassunto della 38ª giornata dell'ambiente ai Lincei (13.12.2021) su Clima e Antartide

Materiale da Jay Pasachoff (Williams College's Solar Eclipse Expedition)
File 1
File 2
File 3



For suggestions&comments write to the Webmaster

Amati Fest

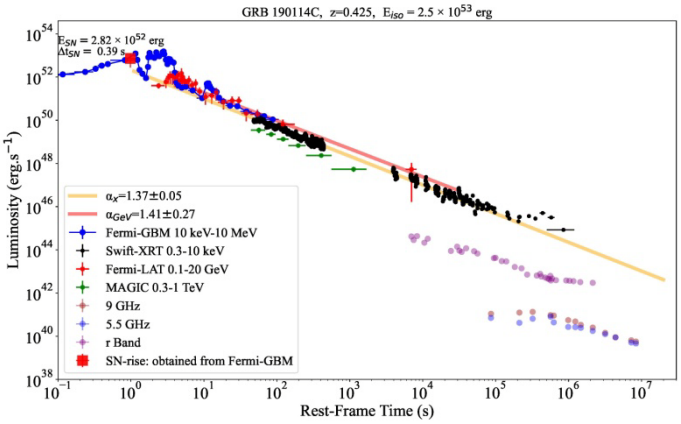
December 6 – 7, 2021

ICRANet Hq (Piazza della Repubblica 10, Pescara, Italy) and online

Link for the GoToMeeting connection: **https://global.gotomeeting.com/join/775351565**

The meeting will be also broadcasted worldwide on ICRANet YouTube channel:
https://www.youtube.com/channel/UCU19scWRGvlIiKBcN1QXCRQ

On the occasion of the 50th anniversary of *"Introducing the Black Hole"*, we are calling a special celebration of the understanding of Gamma-Ray Bursts (GRBs) and their *"inner-engines"*. Particular attention will be given to the understanding of the Amati relation.



Monday December 6, 2021, h 12:00 - Opening remarks

Invited speakers

Prof. Remo Ruffini (*Director of ICRANet*), **Prof. Lorenzo Amati** (*INAF*), **Prof. Marco Tavani** (*President of INAF*), **Prof. Narek Sahakyan** (*Director of ICRANet Seat in Armenia*), **Prof. Michael Kramer** (*Director - Max-Planck-Institut für Radioastronomie*), **Prof. Jorge Armando Rueda Hernandez** (*ICRANet, University of Ferrara*), **Prof. Carlo Luciano Bianco** (*ICRA, ICRANet*), **Prof. Gregory Vereshchagin** (*ICRANet*), **Prof. She Sheng Xue** (*ICRANet*), **Prof. Carlos Raul Arguelles** (*ICRANet, CONICET, Universidad Nacional de La Plata*), **Prof. Soroush Shakeri** (*ICRANet, Isfahan University of Technology*), **Prof. Piero Rosati** (*University of Ferrara*), **Prof. Razmik Mirzoyan** (*Max-Planck-Institute for Physics*), **Prof. Cristiano Guidorzi** (*University of Ferrara*), **Prof. Massimo Della Valle** (*ICRANet, INAF Osservatorio astronomico di Capodimonte*), **Dr Luca Izzo** (*Osservatorio astronomico di Capodimonte)*, **Prof. Yifu Cai** (*University of Sciences and Technology of China*), **Prof. Yefei Yuan** (*University of Sciences and Technology of China*), **Prof. Mimoza Hafizi** (*University of Tirana*), **Prof. Claus Lämmerzahl** (*ZARM University of Bremen*), **Prof. Stefano Scopel** (*CQUeST, Sogang University*), **Prof. Simonetta Filippi** (*ICRA, University Campus Bio-medico of Rome*), **Prof. Christian Cherubini** (*ICRA, University Campus Bio-medico of Rome*), **Prof. Stefano Ansoldi** (*University of Udine*), **Prof. Aldo Treves** (*University of Insubria*), **Prof. Francesco Haardt** (*University of Insubria*), **Dr Ana Penacchioni** (*CONICET, Universidad Nacional de La Plata*), **Dr Laura Marcela Becerra Bayona** (*ICRANet, Universidad Católica de Chile*), **Prof. Wang Yu** (*ICRANet*), **Prof. Liang Li** (*ICRANet*), **Prof. Rahim Moradi** (*ICRANet*), **Dr Yerlan Aimuratov** (*ICRANet, Fesenkov Astrophysical Institute*), **Dr Yunlong Zheng** (*ICRANet, University of Sciences and Technology of China*), **Eduar Antonio Becerra Vergara** (*ICRANet*), **Dr Fatemeh Rastegar Nia** (*ICRANet, Alzahra University*), **Dr Sareh Eslamzadeh Askestani** (*University of Mazandaran*).

Tuesday December 7, 2021, h 18:00 - Closing remarks

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