Supernovae

Contents

1 Topics

- Supernovae (Photometric and Spectroscopic Evolution, Rates)
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- Supernovae-Ia and Gamma-ray Bursts as rulers for cosmological parameters

1.1 ICRANet participants

- Carlo Luciano Bianco
- Filippo Frontera
- Luca Izzo
- Massimo Della Valle
- Lorenzo Amati

1.2 Past collaborators

- John Danziger (INAF-Trieste)
- Roberto Gilmozzi (ESO, Garching, Munchen)
- Mario Livio (STScI, Baltimore)
- Piero Madau (Santa Cruz, California University)
- Nino Panagia (STScI, Baltimore)

- Saul Perlmutter (Lawrence Berkeley National Laboratory, University of California)
- Sumner Starrfield (Arizona State University)
- Evan Scannapieco (Arizona State University)
- Guido Chincarini (Bicocca University, Milano) and the SWIFT team
- Bruno Leibundgut (ESO)

1.3 Ongoing collaborations

- Lorenzo Amati (INAF-Bologna)
- Filippo Frontera (Ferrara University)
- Roberto Gilmozzi (ESO, Garching, Munchen)
- Filippo Mannucci (INAF-Arcetri, Firenze)
- Dani Maoz (Tel-Aviv University)
- Francesca Matteucci (Trieste University, Trieste)
- Ken Nomoto (University of Tokyo)
- Nino Panagia (STScI, Baltimore)
- Andrea Pastorello (Queen's University, Belfast)
- Robert Williams (STScI, Baltimore)
- Martin Henze (Max-Planck)
- Giampiero Tagliaferri (INAF-Milano)
- Sergio Campana (INAF-Milano)
- Enrico Cappellaro (INAF-Padova)
- Massimo Turatto (INAF-Padova)

1.4 Sabatical Visits, 2005-2010

- European Southern Observatory, Munchen (2005)
- STScI, Baltimore, (2005)
- KAVLI Institute, Santa Barbara (2006, 2007)
- Tokyo University (2006)
- Dark Cosmology Center, Niels Bohr Institute, Copenhagen (2007)
- Aspen Center for Physics (2007)
- Queen's University, Belfast (2007)
- European Southern Observatory, Munchen (2008-2009)

1.5 Students

- Cristina Barbarino (IRAP PhD, Italy)
- Vahagn Harutyunyan (ICRAnet PhD, Italy)

2 Brief description

My research field concern the study of several classes of transient phenomena such as: supernovae, gamma-ray bursts and classical novae .

Gamma-ray bursts and their Afterglows. My interest in this area started in 2000 when I became member of the SWIFT follow-up team. Most efforts were (and still are) devoted to the study of the connection between Supernovae and GRBs. I point out 4 highlights from this programme, occurred in the past years: i) the discovery of a transition object (SN 2008D/XRF 080109) between GRBs and standard Core-Collapse SNe; ii) the detection of a GRB-SN at z=0.53 and iii) the discovery of GRB 090423 at z=8.1 that is the farthest GRB ever (spectroscopically) confirmed; iv) the discovery and the follow-up of a new case of association between GRBs and SNe: GRB 130702A/SN 2013dx which takes advantage of the performances of X-shooter at VLT. See item **6**. In item **10** we have presented a preliminary discussion about the amount of the energy budget exhibited by GRBs.

Supernovae. Photometric and the spectroscopic study of all types of SNe (Ia, Ib/c, II-linear, II-plateau) near maximum light and at late stages and their theoretical modeling. The observations at maximum provide us with the necessary data for using SNe (Ia and II) as standard candles. The observations at later stages allow one to discriminate among different energy sources (i.e. radioactive decay, pulsar, light-echo), to model the mechanisms of the explosion, and to shed light on the nature of the progenitor. Most observations are carrried out with ESO telescope in the framework of PESSTO collaboration. See items **2, 5, 7**. The impact of future astronomical projects, such as SKA, on SN studies has been discussed in item **8**.

Supernovae at intermediate-high z. The study of Supernovae has been extended to objects at high-z. The search for SNe at high z is twofold important. On the one hand the evolution of the SN rate with redshift contains unique information on the star formation history of the universe, the IMF of stars and

the nature of the progenitors in Type Ia events. On the other hand SNeI-a at $z \sim 1 - 1.5$ are valuable tracers of cosmological models . Both aspects are currently investigated both on observational and theoretical grounds. See item **1** for our most recent papers on the SN rate issue.

Novae. The systematic study of In collaboration with Bob Williams, Francesca Matteucci, Luca Izzo et al. we carried out the first detection of Lithium in nova spectra. This fact solves a long time conundrum about the origin of the overabundance of Lithium observed in the young stellar population of the Milky Way. See item **4**. Preliminary results on the recent outburst of the recurrent nova T Pyxidis have been presented in item **11**.

Cosmological Parameters with GRBs. Observations of SNe-Ia in the range of redshift $z \approx 0.3 \div 1.3$ (Perlmutter et al. 1998; 1999; Riess et al. 1998; 2004; Schmidt et al. 1998) have shown that their peaks magnitude appear (at $z \sim 0.5$) dimmer than expected by ~ 0.2 mag. This result has been taken as evidence for the existence of a "cosmic jerk", then suggesting that the Universe may accelerate its expansion. On the other hands the cosmological interpretation rely on the lack of evolutionary effects on progenitors of type Ia SNe. Recent results on SNe-Ia progenitors, which imply the existence of two different classes of progenitors for SNe-Ia (Della Valle & Panagia 2003, Della Valle et al. 2005, Mannucci et al. 2005, 2006, 2007, Sullivan et al. 2006, Aubourg et al. 2007) occuring in different environments and at different redshift, may cast some doubts on this assumption. In addition recent versions of the Hubble diagramm for SNe-Ia (e.g. Wood-Vasey et al. 2006) display peculiar distributions of the residuals, which are also suggestive for the presence of systematics. This situation calls for an independent measurement of the cosmological parameters besides the one obtained via SNe-Ia. We show that GRBs can be used to measure $\Omega_M = 0.28$ (see Amati et al. 2008; and Amati & Della Valle 2013). This result has been confirmed through the use of an independent metodology in item **3** The impact of SKA on cosmologu with GRBs has been discussed in item **9**

3 Publications 2013

1. *Supernova rates from the SUDARE VST-OmegaCAM search. I. Rates per unit volume*, Cappellaro et al. 2015, A&A, 584, 62

2. *On the diversity of superluminous supernovae: ejected mass as the dominant factor*, Nicholl, M. et al. 2015, MNRAS, 452, 3869

3. *New measurements of m from gamma-ray bursts*, Izzo, L. et al. 2015, A&A, 582, 115

4. *Early Optical Spectra of Nova V1369 Cen Show the Presence of Lithium*, Izzo et al. 2015, ApJ, 808, L14

5. *PESSTO: survey description and products from the first data release by the Public ESO Spectroscopic Survey of Transient Objects*, Smartt, S. et al. 2015, 579, 40

6. *SN 2013dx associated with GRB 130702A: a detailed photometric and spectroscopic monitoring and a study of the environment*, D'Elia, V. et al. 2015, A&A, 577, 116

7. *Supersolar Ni/Fe production in the Type IIP SN 2012ec*, Jerkstrand, A.et al. 2015, MNRAS, 448, 2482

8. *Core-collapse and Type Ia supernovae with the SKA*, Perez-Torres, M. et al. 2015, Proceedings of Advancing Astrophysics with the Square Kilometre Array (AASKA14). 9 -13 June, 2014. Giardini Naxos, Italy

9. *The SKA contribution to GRB cosmology*, Amati, L. et al. 2015, Proceedings of Advancing Astrophysics with the Square Kilometre Array (AASKA14). 9 -13 June, 2014. Giardini Naxos, Italy

Non-refereed publications

10. *To BEam or not to BEam. . .*, Izzo, L. Della Valle, M., Amati, L. 2015, Extragalactic jets from every angle, Proceedings of the International Astronomical Union, IAU Symposium, Volume 313, pp. 392-393

11. *On the 2011 Outburst of the Recurrent Nova T Pyxidis*, Izzo, L., Della Valle, M., Ederoclite, A., Henze, M. 2015, Acta Polytechnica CTU proceedings, Vol. 2,, p.264-268