Scientific Activity: Massimo Della Valle – 2023

The research activity covers several fields in the observational Astronomy, such as: a) Local and at high redshifts Supernovae (SNe); b) Galactic and extragalactic Novae c) Gamma-ray bursts and their afterglows; d) GRB prompt emission and GRB-SN connection; e) multimessenger astronomy. In 2023 has authored 24 publications, including 13 papers that have been published in major international refereed scientific journals.

Highlights

Supernovae

The study of SNe has concerned both the Core-Collapse[2,12] and the thermonuclear[5] types.

The light curve[2] display two humps of similar maximum brightness separated by 75 days, which is unprecedented for a broad-lined Type Ic supernovae. This could be the result of and interaction scenario, which is supported by the color evolution, which progresses to blue as the light curve evolves along the second hump, and by the slow second rise and subsequent rapid drop. SN 2022xxf may be the first member of an emerging number of CSM-interacting SNe Ic, which show slow, peculiar LCs, blue colors, and subtle CSM interaction lines.

All observations of SN 2021zny[5] support the double degenerate model: a progenitor system consisting of two carbon/oxygen white dwarfs undergoing a merger event. During this event, the disrupted white dwarf ejects carbon-rich circumstellar material before the primary white dwarf undergoes detonation.

The potential neutrino signal emitted by SN 2023ixf in the nearby galaxy M101 (6 Mpc) has been thoroughly analyzed[4], and the horizon discovery distances for both low- and high-energy neutrino signals have been computed. This analysis has led to stringent constraints on the mechanisms responsible for neutrino emission

Novae

The four papers published in 2023 covered all the hot topics in modern astrophysics related to Novae. We discussed Novae's contribution to the chemical evolution of the host galaxy, utilizing the innovative CUBES instrument at the

VLT[10] and by detecting 7Li in RS Oph[11]. Our observations, complemented by a new estimate of the nova rate in the Galaxy[7], resolved the existing discrepancy between the measurements of lithium abundances observed in young stars and the primordial abundance of lithium measured by the Planck satellite.

Finally, we extended the concept of multimessenger astronomy to Nova realm: by estimating, for the first time[8], the potential neutrino signal provided by nova explosions within 1 kpc

Optical counterparts of high energy sources and Gamma-Ray Bursts

Since the 1990s, following observations from the Peppo-Sax satellite, our team has been among the pioneers in studying the connection between supernovae and gamma-ray bursts. While this ongoing work is still in progress[3,6,9,13], there is no doubt that the results described in the paper by Aimuratov et al. 2023[1] represent one of the flagship achievements of ICRANet's activities in 2023. Starting from indisputable observational facts, such as the identification of massive stars as the progenitors of long-duration GRBs and the prevalence of binary systems among massive stars, the study of comprehensive sets of high-energy observations of GRBs have enabled us to identify the progenitor systems of GRBs, in terms of Binary-Hypernova scenario, originally elaborated by Ruffini about 20 years ago (e.g. Ruffini et al. 2001, ApJ, 555, L107). This, in turn, has allowed us to categorize GRBs into three main populations. The paper presents accurate predictions regarding the observational properties of these binary systems, providing valuable insights and suggesting constraints to guide future observations for their detection.

References

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3. A search for the afterglows, kilonovae, and host galaxies of two short GRBs: GRB 211106A and GRB 211227A, Ferro, M. et al. 2023, A&A, 678, 142

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