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Neutron Star Astrophysics at the Crossroads: Magnetars and the Multimessenger Revolution

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COVER ILLUSTRATION:

An artist's impression of a highly magnetized neutron star. Credit: ICRAR/ University of Amsterdam

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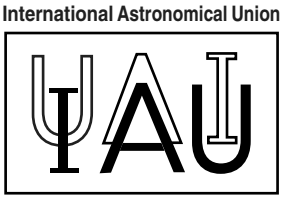

NEUTRON STAR ASTROPHYSICS AT THE CROSSROADS: MAGNETARS AND THE MULTIMESSENGER REVOLUTION

PROCEEDINGS OF THE 363rd SYMPOSIUM OF THE INTERNATIONAL ASTRONOMICAL UNION VIRTUAL MEETING, ITALY 29 NOVEMBER TO 3 DECEMBER, 2021

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Table of Contents

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Preface

This special volume includes contributions from the IAUS 363 Symposium, *Neutron Star Astrophysics at the Crossroads: Magnetars and the Multimessenger Revolution*. It was intended to hold the symposium in Italy in June 2020, at the end of the third LIGO and Virgo observing run. Unfortunately, due to the Covid-19 global pandemic, the symposium was postponed to December 2021 and conducted virtually.

The main goal of this symposium was to address the astrophysical implications of gravitational wave and electromagnetic observations of neutron stars. At its core are offerings on the state of the art understanding of mergers of binary neutron stars producing short gamma-ray bursts, and the most extremely magnetic varieties of neutron stars, magnetars. The papers discuss the status, perspectives and challenges in the blossoming era of multi-messenger astronomy, which is accelerating the path towards a more complete physical picture of neutron stars. The book encapsulates both observations and modeling, addressing extreme transient events including kilonovae, afterglows, magnetar giant flares, and fast radio bursts. By exploring the intersection of studies of isolated neutron stars and binary system synthesis and merging, the ensemble of papers sets the scene for interpreting exciting results pertaining to powerful X-ray, gamma-ray, and gravitational wave transients to be acquired in the next decade and beyond.

The symposium was organized around a morning plenary session followed by two parallel sessions in the afternoon. This format was selected to encourage synergy and cross-fertilization among different communities and, at the same time, to identify and address the most pressing open questions within each field of research. Plenary sessions gave a broad and interdisciplinary overview of neutron stars, their gravitational waves and electromagnetic emission. There were five plenary sessions with the following themes and articles from each are included in these proceedings:

1) Neutron star population and environment
2) Neutron stars and magnetars as sources of gravitational waves
3) Neutron star and magnetar emission processes
4) Neutron star and gamma-ray burst connection
5) Neutron star astrophysics with future observatories

Parallel sessions instead provided a deeper insight into specific questions on the physics of magnetar on one side, and neutron stars as sources of gravitational waves, gamma-ray bursts, and kilonovae on the other. The symposium's program included the following parallel sessions: neutron stars through gravitational wave observations: modeling, search and implications for fundamental physics and astrophysics; neutron star population synthesis and links among diverse neutron star classes; binary neutron star mergers, kilonovae and gamma-ray bursts; magnetars: from their formation to present multiwavelength observations; binary neutron star population and environment through gravitational wave observations and host galaxy studies; magnetars in binary systems; neutron star physics and cosmology with the new generation multi-messenger instruments; neutron star magnetic fields and magnetar magnetospheres.

We wish to extend our gratitude to our organizing institutions and sponsors for supporting the symposium.

Eleonora Troja and Matthew G. Baring

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Abdelmaguid, M.
Aharonian, F.
Ahumada, T.
Amati, L.
Andreoni, I.
Arca Sedda, M.
Artale, M. C.
Ascenzi, S.
Astone, P.
Ayache, E.
Bachetti, M.
Ball, M.
Banerjee, B.
Banerjee, S.
Baring, M. G.
Barrère, P.
Becerra-Gonzalez, J.
Becerra, R.
Becerra Bayona, L.
Berge, D.
Betranhandy, A.
Borghese, A.
Bourgoin, A.
Branchesi, M.
Brice, N.
Brown, D.
Bruni, G.
Bucciantini, N.
Buehler, R.
Bugli, M.
Bulla, M.
Burns, E.
Caiazzo, I.
Camilletti, A.
Castillo, F.
Cataldo, M.
Celora, T.
Chakraborty, A.
Chamel, N.
Chandra, P.
Chen, T.
Chenevez, J.
Chinonso, J.
Choudhury, D.
Chowhan, T.
Chrimes, A.
Colombo, A.
Cooper, A.
Corsi, A.
Coti Zelati, F.
Crosato Menegazzi, L.
Daigne, F.
Danehkar, A.
Dash, L.
D'Avanzo, P.
De Grandis, D.
Dehman, C.
Di Marco, A.
Dichiara, S.
Diez, C.
Dimitropoulos, I.
Ding, H.
Domoto, N.
Donnarumma, I.
Dupletsa, U.
Dvorkin, I.
Dyks, J.
Eggenberger Andersen, O.
Esposito, P.
Finstad, D.
Frey, R.
Fryer, C.
Fujibayashi, S.
Gautam, A.
Ghadimi, A.
Gianfagna, G.
Gittins, F.
Gizzi, D.
Gnarini, A.
Gogus, E.
Gonzalez-Caniulef, D.
Gottlieb, A.
Gourgouliatos, K.
Graber, V.
Greco, E.
Guilet, J.
Hajela, A.
Hanlon, L.
Harding, A.
Hare, J.
Hazra, N.
Heyl, J.
Hirschmann, E.
Hope, J.
Hu, K.
Hurley-walker, N.

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Ibrahim, A.
Igoshev, A.
ILHE, S.
Im, M.
Iosif, P.
Israel, G.
Itoh, Y.
Kalinani, J.
Khanal, A.
Khatiwada, K.
Khokhriakova, A.
Kim, S.
Kirmizibayrak, D.
Klingler, N.
Kojima, Y.
Kolesova, H.
Korol, V.
Kouveliotou, C.
Kramer, M.
Kravtsov, I.
Kulkarni, S.
Kuroda, T.
Kurpas, J.
Laha, S.
Lander, S.
Leaci, P.
Leung, J.
Li, X.
Li, K.
Li, X.
Lin, L.
Linares, M.
Liu, K.
Loffredo, E.
Lopez Armengol, F.
Lyman, J.
Lyutikov, M.
Macquet, A.
Makishima, K.
Mancini Pires, A.
Maselli, A.
Masnou, J.
Mata Sanchez, D.
Mei, A.
Mereghetti, S.
Merfeld, K.
Miani, A.
Miller, J.
Moraga, N.
Murguia-Berthier, A.
Murphy, T.
Mutafchieva, Y.
Nagele, C.
Nakama, Y.
Nathanail, A.
Nativi, L.
Nazari, E.
Negro, M.
Nissanke, S.
Nomoto, K.
Ntotsikas, D.
O'Brien, P.
O'Connor, B.
O'Connor, E.
Ofengeim, D.
Oganesyan, G.
Olivares E., F.
Omand, C.
Orellana, M.
Oswald, L.
Owen, B.
Pacilio, C.
Paek, G.
Palomba, C.
Papitto, A.
Park, S.
Patel, M.
Patricelli, B.
Paul, K.
Pellouin, C.
Penacchioni, A.
Pereyra Talamantes, E.
Pérez Torres, M.
Perna, R.
Piccinni, O.
Pierini, L.
Piro, L.
Pittori, C.
Pnigouras, P.
Popov, S.
Posselt, B.
Possenti, A.
Raaijmakers, G.
Rajwade, K.
Raman, G.
Raynaud, R.
Rea, N.
Reboul-salze, A.
Reisenegger, A.
Rhodes, L.
Ricci, R.
Rigoselli, M.

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Ronchi, M.
Ronchini, S.
Rosinska, D.
Rossi, A.
Sabatucci, A.
Safi-Harb, S.
Sakamoto, T.
Salafia, O.
Salmi, T.
Sarin, N.
Sathyaprakash, B.
Schmidt, P.
Schwope, A.
Scragg, T.
Shawhan, P.
Shen, H.
Shibata, M.
Siellez, K.
Singh, N.
Slane, P.
Slavko, B.
Słowikowska, A.
Song, Y.
Stappers, B.
Stefanou, P.
Stewart, R.
Stiele, H.
Stoyanov, Z.
Stratta, G.
Suleimanov, V.
Suresh, A.
Szewczyk, P.
Szigeti, B.
Taani, A.
Tamba, T.
Tanaka, M.
Taverna, R.
Thakur, A.
Thielemann, F.
Thoene, C.
Tohuvavohu, A.
Tonetto, L.
Topinka, M.
Trevor, M.
Trudu, M.
Turolla, R.
Urrutia, G.
Van Eerten, H.
Viganò, D.
Vinciguerra, S.
Wadiasingh, Z.
Wallis, M.
Wang, Z.
Wang, Y.
Wen, L.
Witte, S.
Yakovlev, D.
Yang, H.
Ye, C.
Yim, G.
Zakharenko, V.
Zane, S.
Zepeda, F.
Zhang, J.
Zhang, B.

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