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Press release

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Colliding neutron stars and their remnants

Prof. Sebastiano Bernuzzi of the University of Jena receives European Research Council (ERC) Consolidator Grant worth nearly two million euros for his current research project, "InspiReM" ("Modeling binary neutron star from inspirals to remnants and their multimessenger emissions").

They are among the most extreme and most complex events in the universe: collisions of neutron stars. When two of these highly compact and massive celestial bodies merge, space-time becomes highly distorted and matter reaches densities and temperatures that cannot be reproduced in any laboratory experiment. In the process, high-energy radiation and matter are hurled into space. The collision is so violent that it can be observed from Earth – even over millions of light years – as both gravitational waves and light.

"Such events are unique astrophysical laboratories," says Prof. Sebastiano Bernuzzi of Friedrich Schiller University Jena. The 40-year-old researcher and his team from the Institute for Theoretical Physics are developing theoretical models with which the dynamics of such cosmic collisions can be understood and data observed can be explained. For his current research project, "InspiReM", Sebastiano Bernuzzi is receiving funding from the European Research Council (ERC) – a Consolidator Grant totalling almost two million euros over the next five years.

"It's the most ambitious project of my scientific career so far," says Bernuzzi, who was awarded an ERC Starting Grant in 2017. He feels honoured that his study is now one of the projects selected to receive the ERC's most important funding and also the EU's highest award for top researchers. "I'm excited, and at the same time determined, to push my research to the highest possible level," adds Bernuzzi.

Predicting gravitational and electromagnetic waves with the help of Einstein's theory of relativity

Bernuzzi's working group at the University of Jena is already a leader in the field of numerical simulation of neutron star mergers. To this end, the researchers use Germany's largest supercomputers at the Leibniz Supercomputing Centre (Munich) and the HRLS (Stuttgart) to make detailed predictions for gravitational waves and electromagnetic observations emanating from such events, by solving Einstein's theory of general relativity. "By simulating what happens to space-time as stars merge, we can create detailed models for interpreting the radiation we observe," says Bernuzzi. Just recently, Bernuzzi was part of an international team analysing data recorded by the NASA X-ray Observatory "Chandra" during the merger of two neutron stars in object GW170817 (https://www.uni-jena.de/en/220228-gw170817-afterglow).

Bernuzzi and his team want to use the InspiReM project ("Modeling binary neutron star from inspirals to remnants and their multimessenger emissions") not only to focus on gravitational waves, but also to study the remnants of past stellar mergers and the outflows of material from them. The unique matter conditions in the outflows are such that heavy elements – gold or uranium, for example – may be created there. The ERC funding will enable Bernuzzi to strengthen his team with the best researchers from all over the world. Part of the money will also go towards further high-performance computing technology for the university computer centre, without which his complex simulations

would not be possible.

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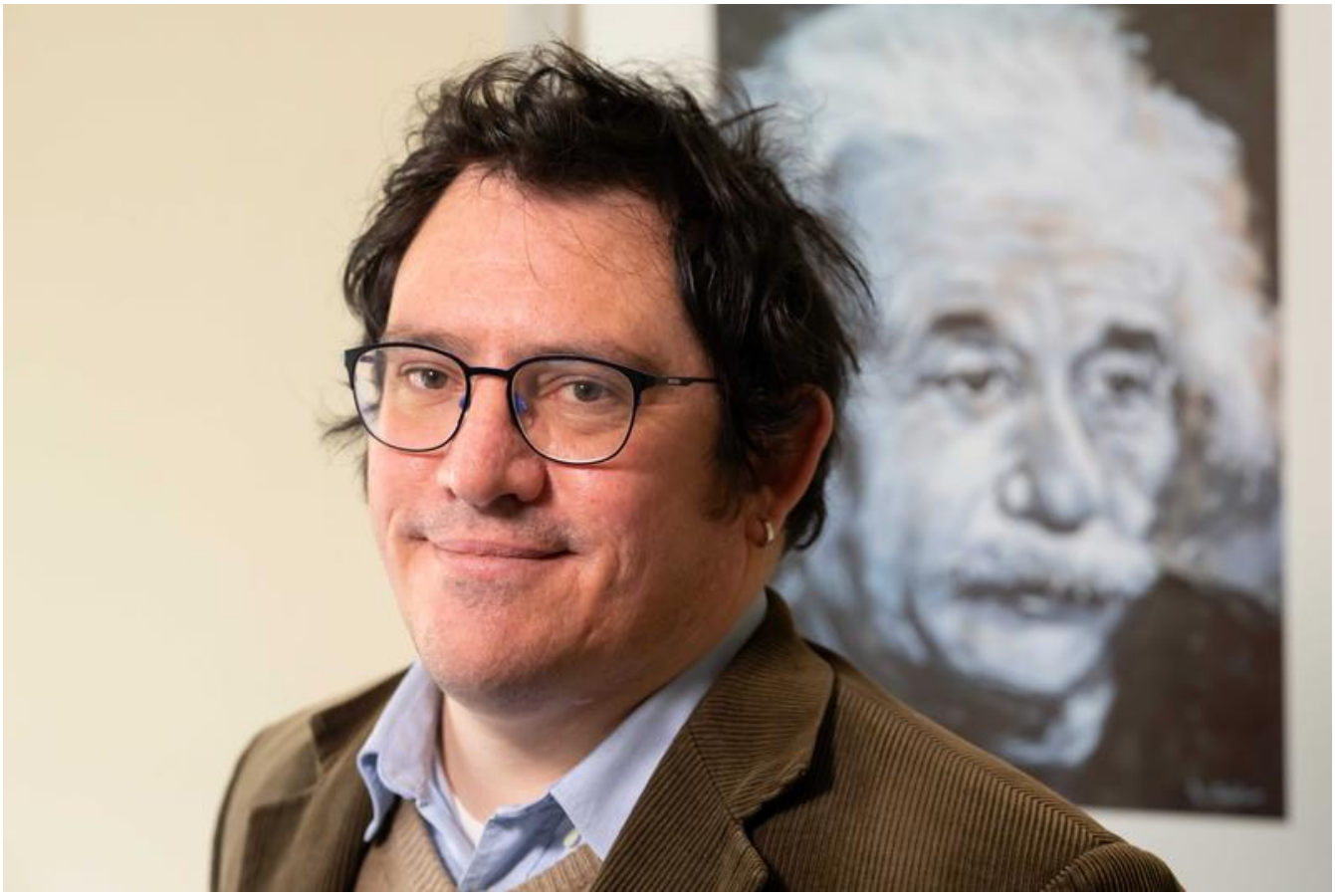

Prof. Dr Sebastiano Bernuzzi is funded with an ERC "Consolidator Grant". He and his team use Einstein's theory of general relativity to make predictions for gravitational waves and electromagnetic observations emanating from neutron star collisions.
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