IAS Workshop Report

Neutron Stars

Nuclear Physics, Gravitational Waves and Astronomy

29-30 July 2013

Summary

A basic cornerstone of modern physics is the quest to describe quantitatively the properties of nuclear matter. Neutron stars are unique beacons in this journey, as their interiors expose matter to extreme regimes of density, temperature and magnetic field not accessible to terrestrial experiments. Astronomical observations in the full electromagnetic spectrum help us characterize these stars and, with that, we can infer the properties of neutron-rich environments. Moreover, the intense gravitational fields in these astrophysical compact objects, particularly in binaries, will give rise to potentially detectable signals in the next generation of gravitational wave detectors. Better and more reliable theoretical tools and a more thorough modelling are required to interpret observations and connect them to the underlying microphysics. By the very nature of the system, this task has to be carried out by a multidisciplinary community of scientists covering a wide variety of fields.

Our workshop provided a gathering point for over 40 international experts in the different disciplines relevant to neutron star physics. The 26 talks (13 each day) were all excellent, at a truly international and cutting-edge level. 6 worldwide research leaders delivered compelling keynote talks. All speakers made an effort to communicate with as wide an audience as possible. We take some talk titles, such as “I Love Q forever” or “Why is lead so kinky?”, as an example of the engaging spirit of the meeting. The discussions after talks were lively and provided a good opportunity for the attendees to deepen their knowledge in their own field, but also to gather a more horizontal perspective on neutron star research. An evening poster session gave some early career researchers the chance to present their results in a more informal environment.

Talks online

A website was prepared by the organizers to keep all talks and photos available online. These can be found at: http://personal.ph.surrey.ac.uk/~m01088/IAS/Talks.html

Youtube videos were produced from interviews of two international leading figures on neutron star research:

Prof. Mark Alford (Washington University at St Louis, USA)
http://www.youtube.com/watch?v=5rJjLr87blw&feature=youtu.be

Prof. Ben Stappers (Manchester University & Jodrell Bank, UK)
http://www.youtube.com/watch?v=qMQVvYU-gSM&feature=youtu.be

Event themes

The meeting was truly multidisciplinary. Neutron star research was discussed from a variety of perspectives, ranging from observational radioastronomy to experimental nuclear physics and from pure general relativity theory all the way to quantum many-body physics. It is difficult to highlight specific topics, but ideas that were discussed include:

1. Radio observations of pulsars and general relativity tests
2. X-ray observations of pulsars and the LOFT satellite mission
3. Gravitational wave searches and their theoretical modelling
4. Neutron star cooling and superfluidity of dense matter
5. Glitches in pulsars: microphysics and macrophysics implications
6. Magnetic fields: atomic physics effects in white dwarfs and field distribution in neutron stars
7. Magnetars: infuence of the pasta phase on spin-down properties
8. Neutron star equation of state: constraints from future gravitational wave and supernova observations

9. Neutron star equation of state: theoretical predictions from quantum many-body theory
10. General relativistic instabilities in neutron stars
11. Nuclear experiments: neutron skin thickness via parity violating scattering and pion photoproduction
12. Implications of quark matter in neutron star interiors

Outcomes

Future publication plans with the Southampton group were discussed, particularly on the area of neutron star cooling. Moreover, as a result of this meeting, Surrey has positioned itself as one of the leading UK institutions on neutron star research. Surrey group members are now part of the LOFT dense matter group and will provide guidance on the Yellow Book. This will be used by ESA to consider the potential launch of this M-class X-ray satellite mission in the 2020s. Surrey will also play an important role in the NewCompStar initiative, a European, COST-funded strategy to sponsor the collaborative study of neutron stars from a variety of perspectives.

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Organizers

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