

# MODE workshop, Bordeaux, 15/11-17/11/2010

## 1 Summary

Over the last decade an enormous amount of new information about neutron stars has been accumulated by the satellites like XMM-NEWTON, CHANDRA, INTEGRAL, FERMI, and the earth laboratories, in particular the different radio-telescopes, but also the HESS observatory. Moreover, very interesting informations are expected to shed light on compact stars in the near future thanks to the gravitational-wave detectors like VIRGO and LIGO. Various new phenomenons related for instance to the enormous magnetic fields (Flares and QPO), to the reheating of the crust or to pulsar wind nebulae in supernovae remnants have been observed. A thorough understanding of all these phenomena requires to bring together leading and promising young researchers from all the fields. Important issues to address include: What can we learn from these new observations about neutron star structure and the radiation mechanism? Which models shall be developed to analyze the new data? What would be key observations for the future? The aim of the workshop was to help the three communities to exchange with each other as well as discussing internal advanced issues.

## 2 Scientific content

In order to encourage discussion, the workshop has been organized with parallel specialized sessions as well as plenary sessions with reviews and a round table. The subjects of the review talks were

- Magneto-thermal evolution of neutron stars (J. Pons)
- Supernova explosions (T. Foglizzo)
- LOFAR busy weeks (J. Hessels)
- Cosmic ray leptons and hadrons from PWNe and SNRs (P. Blasi)

In addition to the review talks, the main subjects discussed in plenary sessions concerned the magnetic field of neutron stars, oscillations of neutron stars, models for emission of neutron stars and pulsar searches in different wavelengths.

One parallel session concerned mainly the equation of state (EOS) of cold neutron star matter. In view of the recent observation of a pulsar with a mass of almost two solar masses ( $M(\text{PSR J1614} - 2230) = 1.97 \pm 0.04 M_{\odot}$ ) [1], the main question in this context was the existence of “exotic” (hyperons, mesons, quarks) matter in neutron stars. Most of the EOS containing exotic matter are too soft to explain this high-mass pulsar. P. Haensel showed in his talk that the inclusion of short-range repulsion between hyperons via the introduction of additional vector mesons in a relativistic mean field model for the nuclear interaction renders high-mass stars with hyperons possible. Within the more microscopic Brueckner-Hartree-Fock theory this seems more difficult, as discussed by I. Vidaña and F. Burgio, but many uncertainties on the hyperon-hyperon and hyperon-nucleon interaction remain. During the discussion, J.

Hessels, one of the authors of [1], presented briefly the observations and the method to extract the pulsar mass from the observations using Shapiro delay.

Another parallel session concerned different aspects of core collapse supernova modelisation. The two main points discussed during this session were the possibility of a successful explosion if there is an early phase transition (for example to quark matter, talk by I. Sagert) and the description of the transition from inhomogeneous nuclear matter to homogeneous nuclear matter. F. Gulminelli presented on this subject a coherent statistical treatment of the different nuclear phases.

Two other parallel sessions were organized around the observation of supernova remnants and pulsar wind nebulae in different wavelengths by Fermi, HESS and XMM-Newton.

### **3 Impact of the event**

The workshop followed a first edition in Meudon (France) in november 2009 which was a first attempt to encourage discussions and to build up relations between the different communities which is not always evident. The organization of the workshop with review talks in plenary sessions and parallel sessions with more specialized topics was a slight modification with respect to last year with exclusively plenary sessions. The duration has been changed from five to three days, too. This modification has to be seen as a success since, without cutting the discussion on some more specialized subjects, the discussion around the talks showed that interest on all sides has been stimulated. A first concrete point was the interaction between nuclear physicists and observers on PSR J1614-2230. Another point of interaction concerned the asymmetry of supernova explosions. In conclusion, the contact has been established and future editions of the workshop seem very promising for further advances.

### **4 Final program**

The list of the all talks together with the slides is available on-line on the following web-page <http://www.cenbg.in2p3.fr/heberge/MSPWorkshop/spip.php?rubrique10>

### **References**

- [1] P. Demorest et al, Nature 467 (2010) 1081.