

Theoretical Issues in Nuclear Astrophysics

IPN Orsay, France.

March, 31 - April 4, 2008.

Organisers: B. Carter (LUTH, Meudon), J. Margueron (IPN, Orsay) and P. Schuck (IPN, Orsay)

SCIENTIFIC REPORT

Summary

The aim of this meeting is to promote discussions and collaborations among people working in Astrophysics, Nuclear Physics and Particle Physics, including both observers and theorists. It is somehow the image of CompStar but at a more local scale, and with less topics. It is held in Orsay in the early spring since 2004.

Description of the scientific content and discussion of the event

The understanding of the complex physical phenomena in compact objects requires expertise from virtually all branches of physics. It is thus essential to build up bridges between workers in different subfields in order to gain an overall physical picture of compact stars and confront the theory with experimental results of high energy physics and astrophysics. It is the aim of this meeting to build up bridges between workers in different subfields and to provide a forum for cross-talk in order to gain an overall physical picture of compact stars and confront the actual status of the theory with newest experimental results of nuclear physics; high energy physics and astrophysics. This meeting was timely since we are witnessing now the wake of a new era in compact star physics: the observational data are gaining a precision which is sufficient to put tight constraints to the theory of dense matter. In this situation it is of utmost importance that theorists talk to those observers producing decisive data points, before they abandon theories which seem not to full observational constraints. On the other hand, the cross-

fertilizing theory-meets-experiment experience of this meeting may help to identify laws of puzzling observations before big efforts are started to develop intricate models in the attempt to explain them. Inputs and constraints on models could also come from experiments on earth, using for instance exotic ion beams at nuclear energies. Main questions are: how the nuclear incompressibility is changing in neutron rich matter ? Could one rely the equation of state in neutron matter with measurements in nuclei like symmetry energy, collective modes, neutron skins ? How to extrapolate the models for pairing in nuclei towards the neutron rich cells present in the inner crust of neutron stars ? In the following we setup the list of speakers sorted according to their domain:

Observers:

- Gilles Theureau : *Long term pulsar observations with the Nancay Radio Telescope and the associated scientific collaborations*
- Isabelle Grenier : *GLAST and the gamma-ray pulsars: constraints on the polar-cap, slot-gap, and outer-gap models*
- Anne Lemière : *Pulsar wind nebulae: models and observations*

Nuclear physicists:

- Francesca Gulminelli : *Finite temperature nuclear matter at low density*
- Hiroyuki Sagawa : *Isospin dependent pairing interaction in nuclear matter and in finite nuclei*
- Nicolae Sandulescu : *Properties of pairing correlations in weak, intermediate and strong coupling regimes*
- Toshio Suzuki : *Nuclear structure and nucleosynthesis*
- Sebastien Figero : *Self-consistent investigation of structural transitions in neutron star crusts*
- Elias Khan : *Towards the measurement of the incompressibility modulus in neutron rich matter*
- Isaac Vidana : *Spinodal instabilities within the Brueckner-Hartree-Fock approach*
- Camille Ducoin : *Unstable density fluctuations in nuclear matter*
- Gerd Roepke : *Clusters formation and nuclear matter symmetry energy*
- Zenghua Li : *Consistent nucleon-nucleon potential and three-body forces*

Particle Physicists:

- David Blaschke : *Down-quark dripline in compact stars?*
- Michael Urban : *Surface of color superconducting strange quark matter*

Astrophysicists:

- Dorota Gondek-Rosinska : *Influence of the equation of state on the final phase of the coalescing binary neutron stars*
- Pawel Haensel : *Deep crustal heating and soft X-ray transients*
- Leszek Zdunik : *Rapidly rotating compact stars*
- Armen Sedrakian : *Superfluid compact stars: from meso to macrophysics*
- Nicolas Chamel : *Superfluidity in neutron star crust*
- Sebastian Kubis : *Neutron stars with non-homogeneous core*
- Patrick Blottiau : *Type II supernovae and weak processes*

Assessment of the results and impact of the event on the future direction of the field

The meeting “Theoretical Issues in Nuclear Astrophysics” at IPN Orsay provided the frame for an extremely useful and timely dialog between theorists and observers. Given a wealth of new observational material from satellite missions such as Chandra, XMM Newton, as well as ground based observatories we have entered an era where astrophysical measurements of compact star properties reach the precision level required to falsify assumptions about the properties of strongly and electro-weakly interacting matter at extreme densities. These results complement information from laboratory experiments with heavy-ion collisions which access a different domain in the phase diagram of dense matter. Due to the complexity of the physics involved in this thematic it is ideally suited for both, networking activities of many European groups as well as a comprehensive long-term training course for young scientists. The participants would welcome the continuation of meetings on this thematic on an annual basis.

Optional:

The talks can be browsed from the website:

<http://snns.in2p3.fr/meetings/0804meeting.html>

Final program of the meeting

MONDAY, 31 th	
14h20-14h40	<i>Registration and welcome</i> Peter Schuck
14h40-15h20	<i>Influence of the equation of state on the final phase of the coalescing binary neutron stars</i> Dorota Gondek-Rosinska
15h20-16h00	<i>Deep crustal heating and soft X-ray transients</i> Pawel Haensel
	Break
16h20-17h00	<i>Long term pulsar observations with the Nancay Radio Telescope and the associated scientific collaborations</i> Gilles Theureau
17h00-17h40	<i>Rapidly rotating compact stars</i> Leszek Zdunik
17h40-18h20	<i>Finite temperature nuclear matter at low density</i> Francesca Gulminelli
TUESDAY, 1 st	
10h00-10h40	<i>GLAST and the gamma-ray pulsars: constraints on the polar-cap, slot-gap, and outer-gap models</i> Isabelle Grenier
10h40-11h20	<i>Superfluid compact stars: from meso to macrophysics</i> Armen Sedrakian
	Break
11h40-12h20	<i>Superfluidity in neutron star crust</i> Nicolas Chamel
12h20-13h00	<i>Isospin dependent pairing interaction in nuclear matter and in finite nuclei</i> Hiroyuki Sagawa
	Lunch
14h30-15h10	<i>Properties of pairing correlations in weak, intermediate and strong coupling regimes</i> Nicolae Sandulescu
19h	Social diner (Le Gramophone, Orsay)
WEDNESDAY, 2 nd	
10h00-10h40	<i>Nuclear structure and nucleosynthesis</i>

	Toshio Suzuki (pdf)
10h40-11h20	<i>Neutron stars with non-homogeneous core</i> Sebastian Kubis
	Break
11h40-12h20	<i>Self-consistent investigation of structural transitions in neutron star crusts</i> Sebastien Figerou
12h20-13h00	<i>Towards the measurement of the incompressibility modulus in neutron rich matter</i> Elias Khan
	Lunch
14h30-15h30	Group seminar (see the announce)
THURSDAY, 3 rd	
10h00-10h40	<i>Spinodal instabilities within the Brueckner-Hartree-Fock approach</i> Isaac Vidana
10h40-11h20	<i>Unstable density fluctuations in nuclear matter</i> Camille Ducoin
	Break
11h40-12h20	<i>Clusters formation and nuclear matter symmetry energy</i> Gerd Roepke
12h20-13h00	<i>Consistent nucleon-nucleon potential and three-body forces</i> Zenghua Li
	Lunch
FRIDAY, 4 th	
10h00-10h40	<i>Pulsar wind nebulae: models and observations</i> Anne Lemièr
10h40-11h20	<i>Type II supernovae and weak processes</i> Patrick Blottiau
	Break
11h40-12h20	<i>Down-quark dripline in compact stars?</i> David Blaschke
12h20-13h00	<i>Surface of color superconducting strange quark matter</i> Michael Urban
	Lunch

List of speakers and participants

List of Participants		
Naftali Auerbach	Univ. of Tel-Aviv, Israel	27/03 - 07/04
David Blaschke	Univ. of Wroclaw	3 days
Patrick Blottiau	CEA-DAM Bruyères-le-chatel, France	
Brandon Carter	LUTH Meudon, France	
Nicolas Chamel	Univ. libre de Bruxelles, Belgium	31/03 - 04/04
Virginia De la Mota	SUBATECH Nantes, France	02/04 - 03/04
Camille Ducoin	Univ. of Catania, Italy	31/03 - 04/04
Anthea Fantina	IPN Orsay, France	
Sébastien Figerou	SUBATECH Nantes, France	31/03 - 04/04
Francesca Gulminelli	LPC Caen, France	31/03 - 03/04
Dorota Gondek-Rosinska	Univ. Zielona Gora, Poland	31/03 - 04/04
Kouichi Hagino	Tohoku Univ., Sendai, Japan	27/03 - 04/04
Marcella Grasso	IPN Orsay, France	
Isabelle Grenier	SAP CEA, Saclay	
Pawel Haensel	CAMK Warsaw, Poland	30/03 - 04/04
Karim Hasnaoui	GANIL Caen, France	
Elias Khan	IPN Orsay, France	
Zenghua Li	INFN-LNS Catania, Italy	27/03 - 04/04
Umberto Lombardo	INFN and univ. of Catania, Italy	27/03 - 04/04
Zhongyu Ma	CIAE Beijing, China	
Piotr Magierski	Warsaw univ. of Technology, Poland	30/03 - 05/04
Jérôme Margueron	IPN Orsay, France	
Jesus Navarro	IFIC Valencia, Spain	28/03 - 05/04
Micaela Oertel	LUTH Meudon, France	
Xavier Roca	ECM, Univ. of Barcelona, Spain	31/03 - 03/03
Gerd Roepke	Univ. of Rostock, Germany	31/03 - 04/04
Hiroyuki Sagawa	Univ. of Aizu, Japan	27/03 - 02/04

Nicolae Sandulescu	NIPNE Bucharest, Romania	31/03 - 04/04
Peter Schuck	IPN Orsay, France	
François Sebillé	SUBATECH Nantes, France	02/04 - 03/04
Armen Sedrakian	Goethe univ., Frankfurt, Germany	31/03 - 04/04
Toshio Suzuki	Nihon University, Japan	28/03 - 05/04
Gilles Theureau	GEPI, Observ. Paris and LPCE, Orléans	
Michael Urban	IPN Orsay, France	
Nguyen Van Giai	IPN Orsay, France	
Isaac Vidana	ECM, Univ. of Barcelona, Spain	31/03 - 04/04
Xavier Vinyas	ECM, Univ. of Barcelona, Spain	31/03 - 03/04
Leslej Zdunik	CAMK Warsaw, Poland	31/03 - 04/04