

# Compact Objects

Home Rationale Program  
Lectures Participants Poster



INPE Advanced Course - II  
Compact Objects

September 10-14, 2007  
São José dos Campos, SP Brazil

Invited Lecturers

Brian Warner  
Cataclysmic variables

Kostas D. Kokkotas  
Generation mechanisms of gravitational waves

Feryal Özel  
Compact objects

Ronald A. Remillard  
Accretion processes in neutron stars and black holes

Advisory Committee

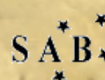
N. Andersson - University of Southampton - United Kingdom  
L. Bildsten - University of California at Santa Barbara - USA  
D. Blair - University of Western Australia - Australia  
A. Bruch - Laboratório Nacional de Astrofísica - Brazil  
M. Coleman Miller - University of Maryland - USA  
V. Ferrari - Università di Roma "La Sapienza" & INFN/Roma - Italy  
J.A. de Freitas Pacheco - Observatoire de la Cote d'Azur - France  
C. Hellier - Keele University - United Kingdom  
J. Horvath - University of São Paulo - Brazil  
J. McClintock - Harvard-Smithsonian Center for Astrophysics - USA  
R. Rothschild - University of California at San Diego - USA  
R. Sunyaev - Max Planck Institute for Astrophysics - Garching - Germany

Local Organizing Committee

O. D. Aguiar, J. C. N. de Araujo, J. Braga, F. D'Amico, F. J. Jablonski,  
O. D. Miranda, C. V. Rodrigues



DAS  
Divisão de Astrofísica



Av. dos Astronautas, 1.758 - Jd. Granja - CEP 12227-010  
São José dos Campos - SP - Brazil  
**Email** - [school@das.inpe.br](mailto:school@das.inpe.br)  
**Phone** - +55 (12) 3945 7200

2007 INPE. All rights reserved.  
**Webmaster** - [Marcelo Bastos](#)

# Compact Objects

Home Rationale Program  
Lectures Participants Poster



## Rationale

The first edition of INPE's Advanced Course on Astrophysics, in 2005, dealt with prospects and perspectives on Cosmology, literally a "roadmap" to Cosmology. As an opportune complement, the second edition of the Course reaches aspects of both extragalactic and galactic astrophysics: Compact Objects.

The natural examples of what we call "compact objects" display configurations in which degenerate matter prevails -- white dwarfs, neutron stars and maybe exotic matter stars -- and configurations in which no known pressure mechanism is able to avoid gravitational collapse: the so-called black holes.

Binarity plays a conspicuous role in turning compact configurations of matter observable since companions -- in the form of gaseous stars or even the interstellar medium itself -- provide plenty of gas for accretion. This gas, for its part, converts gravitational potential energy into other forms of energy making such systems visible at great distances. Binarity also plays a crucial role in producing impulsive events of emission of gravitational waves.

The configurations resulting from the exposure of different kinds of compact objects to plenty of gas provide us a plethora of observational phenomena: white dwarfs accreting matter from main sequence stars show up as "Cataclysmic Variables". Here, the presence or absence of magnetic field in the compact object produce new configurations rich in rare observables such as circular polarized radiation. No less important, the magnitude of the accretion rate by the compact object defines regimes in which the ambient plasma behaves like a viscous or non-viscous fluid, with associated instabilities that produce the Dwarf Nova eruptions. The long-term characteristics of accretion onto white dwarfs are equally responsible for a fraction of the pollution of the interstellar medium with nucleosynthetic products -- via Novae and SN I explosions -- and as a consequence, by a fraction of the chemical enrichment of the Galaxy itself.

Neutron stars possess gravitational potential wells a thousand times deeper than the equivalent for white dwarfs. In this circumstance, the phenomenology shifts to proportionally higher energies. Compact objects accreting gas from companion stars or from the interstellar medium show up as X ray and Gamma ray sources. Again, a myriad of effects come up in response to these different physical conditions. Non-magnetized neutron stars show eruptions of low-Q quality in the repetition rate, as can be seen in relaxation oscillators, while rotating magnetized objects manage to channel the captured matter producing X ray pulsars, and in extreme conditions, powerful releases of energy as observed in magnetars. Tight configurations of neutron stars in inspiralling motion with respect to each other produce strong deformation in the space-time fabric in scales of meter/kilometer and fractions of a millisecond providing, together with supernovae collapses, the most probable sources for the first detections of gravitational waves.

Black Holes, according to the canonical view, do not have firm theoretical limits for their masses. They are observed in Nature from a few solar masses (as in binary systems) up to 100 million solar masses (as in galactic nuclei). Again, the phenomenology is vast and intervening agents such as magnetic fields are able to produce configurations that mankind only came to know in the 20th century, like extragalactic jets with dimensions exceeding by a factor of a hundred the dimension of a normal galaxy.

The theories to explain the variety of observables presented by Compact Objects will be addressed at INPE's II Advanced Course on Astrophysics by a team of renowned lecturers:

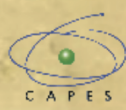
Brian Warner is responsible for several discoveries in the field of Cataclysmic Variables. His textbook "Cataclysmic Variables" is the basic reference for students and researchers. Since the configuration involving a white dwarf as a compact object in binary system was only fully recognized in the second half of the 20th century, we can surely say that Warner has not only created parts of, but fully witnessed the development of this branch of knowledge.

Kostas Kokkotas has important contributions on the study of Quasi-Normal Modes of Pulsating Relativistic Stars.

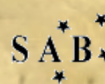
In particular, working in collaboration with Bernard Schutz and Nils Andersson, he has found a new family of normal mode frequencies: the w-modes, which are mainly modes of the spacetime and not of the fluid. These modes have no analog in Newtonian theory. They have also proven the existence of Axial Modes for normal stars, showing that they are practically spacetime modes. He has also studies on the statistical analysis of the estimators of the Newtonian and post-Newtonian parameters of the gravitational wave signal from a coalescing binary from one or a network of detectors.

Feryal Özel works on physics of compact objects, high energy astrophysics, neutron stars, magnetars, black holes, accretion disks, and gravitational lensing. Among other things she has been working on determining the signatures of ultrahigh magnetic fields and identifying them in Anomalous X-ray Pulsars and Soft Gamma-ray Repeaters. One of her important contributions on the physics of compact objects has to do with the determination of the mass and radius of the neutron star EXO 0748-676 that appears to rule out all the soft equations of state of neutron-star matter. She has received many honours and awards including the NASA Hubble Postdoctoral Fellowship.

The sub-topic "Accretion on neutron stars and black holes" will be presented by Ronald A. Remillard. He is one of the principal investigators behind the All Sky Monitor (ASM) onboard the Rossi X-ray Timing Explorer (RXTE) satellite, a fundamental mission for high energy astrophysics. Ron has scored as chapter author in the two bibles of the high energy community ("X-ray Binaries", from 1995 and its successor "Compact Stellar X-ray Sources", 2006), with both observational and theoretical contributions. He is recognized as one of the most important researchers in the field of compact objects.



**DAS**  
Divisão de Astrofísica



Av. dos Astronautas, 1.758 - Jd. Granja - CEP 12227-010  
São José dos Campos - SP - Brazil  
**Email** - [school@das.inpe.br](mailto:school@das.inpe.br)  
**Phone** - +55 (12) 3945 7200

2007 INPE. All rights reserved.  
**Webmaster** - [Marcelo Bastos](#)





The conference will take place in São José dos Campos from September 10-14, 2007, at the auditorium Fernando de Mendonça of the Laboratório de Integração e Testes of the Instituto Nacional de Pesquisas Espaciais.

Program

- I - Cataclysmic variables
- structure of non-magnetic systems

- dwarf novae, nova-like variables and nova remnants

- novae in eruption

- magnetic cataclysmic variables

- evolution of cataclysmic variables
- II - Generation mechanisms of gravitational waves
- pulsating modes of neutron stars

- quasinormal modes of black-holes

- compact binary systems: periodic, chirp, and impulsive emission

- monochromatic waves from single compact objects

- burst emission (e.g., from supernovae)

- stochastic emission (cosmological backgrounds, overlap of sources such as double white dwarf systems)
- III - Compact objects
- structure of white dwarfs

- structure of neutron stars

- physical description of black holes

- strange stars
- IV - Accretion processes in neutron stars and black holes
- jets and microquasars

- millisecond pulsars

- ADAF (and beyond!) models

- accretion flows

- thermonuclear Bursts

- high and low states of luminosity: spectral behaviour

- cyclotron resonant scattering features

Registration: Monday 8:00  
Opening session: Monday 8:30

Schedule					
	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 - 10:15	I	I	I	I	I
10:15 - 10:45	COFFEE-BREAK				
10:45 - 12:00	II	II	III	III	III
12:00 - 14:00	LUNCH				
14:00 - 15:15	II	II	IV	III	III
15:15 - 15:45	COFFEE-BREAK				
15:45 - 17:00	IV	IV	-	IV	IV



DAS

Divisão de Astrofísica



S A B

★ ★ ★

Av. dos Astronautas,1.758 - Jd. Granja - CEP 12227-010

São José dos Campos - SP - Brazil

Email - [school@das.inpe.br](mailto:school@das.inpe.br)

Phone - +55 (12) 3945 7200

2007 INPE. All rights reserved.

Webmaster - [Marcelo Bastos](#)

# Compact Objects

Home Rationale Program  
Lectures Participants Poster



## Lectures

Generation mechanisms of gravitational waves  
Kostas D. Kokkotas

Lecture 1  
Lecture 2  
Lecture 3  
Lecture 4  
Lecture 5

Compact Objects  
Feryal Özel

Lecture 1  
Lecture 2  
Lecture 3  
Lecture 4  
Lecture 5

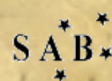
Accretion processes in neutron stars and black holes  
Ronald Remillard

Lecture 1  
Lecture 2  
Lecture 3  
Lecture 4  
Lecture 5

Cataclysmic variables  
Brian Warner



**DAS**  
Divisão de Astrofísica



Av. dos Astronautas, 1.758 - Jd. Granja - CEP 12227-010  
São José dos Campos - SP - Brazil  
**Email** - [school@das.inpe.br](mailto:school@das.inpe.br)  
**Phone** - +55 (12) 3945 7200

2007 INPE. All rights reserved.  
**Webmaster** - [Marcelo Bastos](#)





Participants

Nº	Name	Affiliation
1.	Albert Bruck	LNA
2.	Adriana Pires	IAG/USP
3.	Alexandre Bortoletto	IAG/USP
4.	Alexandre Oliveira	UNIVAP
5.	André Barros	INPE
6.	André Milone	INPE
7.	Artur Justiniano	LNA
8.	Bárbara H. Rodrigues	INPE
9.	Bernardo Borges	UFSC
10.	Carlos A. M. Velasquez	Obs. Valongo
11.	Carlos Brandt	UFRGS
12.	Carlos E. P. de Oliveira	USP
13.	Cecilia Chirenti	IF/USP
14.	Cesar Costa	INPE
15.	Claudia V. Rodrigues	INPE
16.	Cláudio Brandão	INPE
17.	Cleber Souza	INPE
18.	Cristiane Godoy Targon	INPE
19.	Daniel Guariento	ITA
20.	Dennis Bessada	INPE
21.	Deonisio Cieslinski	INPE
22.	Douglas Fregolente	IMECC/Unicamp
23.	Edgard F. D. Evangelista	INPE
24.	Eduardo S. Pereira	INPE
25.	Fabiola Ribeiro	IAG/USP
26.	Flavio D'Amico	INPE
27.	Francisco J. Jablonski	INPE
28.	Glaucia Balvedi	ITA
29.	Guilherme Leite Pimentel	ITA
30.	Guilherme Marranghello	UFPampa
31.	Helmo Alan Batista de Araújo	ITA
32.	Ivan Ferreira	INPE
33.	Jaziel Goulart Coelho	ITA
34.	Joao Braga	INPE
35.	Joaquim Costa	INPE
36.	Jorge Ernesto Horvath	IAG/USP
37.	José C. N. Araujo	INPE
38.	Julio César Tello Gálvez	INPE
39.	Karleyne M. G. da Silva	INPE
40.	Karlúcio Castello-Branco	USP/São Carlos
41.	Laura Paulucci	IF/USP
42.	Leonardo Almeida	INPE
43.	Lubianka Ferrari	ITA
44.	Manoel Moraes	IAG/USP
45.	Marcelo Vidalis	ITA
46.	Marcio Avellar	IAG/USP
47.	Márcio E. da Silva Alves	INPE
48.	Marcos Diaz	IAG/USP
49.	Odylio Aguiar	INPE
50.	Oswaldo D. Miranda	INPE
51.	Pamela Piovezan	IAG/USP
52.	Priscilla Polido	INPE
53.	Raul Puebla	IAG/USP
54.	Reinaldo Caraça	INPE
55.	Richard Rothschild	UCSD - USA
56.	Roberto Saito	UFSC
57.	Rodrigo Panosso Macedo	IF/USP
58.	Rubens Marinho	ITA
59.	Tiago Ribeiro	UFSC



# II INPE ADVANCED COURSE ON ASTROPHYSICS



*figura 1*

## *Compact Objects*

Cataclysmic variables  
**Brian Warner**

Gravitational Waves:  
Generation Mechanisms  
**Kostas D. Kokkotas**

Structure of compact objects  
**Feryal Özel**

Accretion processes in neutron stars  
and black holes  
**Ronald A. Remillard**

**São José dos Campos - SP  
BRAZIL**

**September 10 - 14, 2007**

LOC:

O. D. Aguiar  
J. C. N. de Araujo  
J. Braga  
F. D'Amico  
F. J. Jablonski  
O. D. Miranda  
C. V. Rodrigues

SOC:

N. Andersson  
L. Bildsten  
D. Blair  
A. Bruch  
M. Coleman Miller  
V. Ferrari  
J. A. de Freitas Pacheco  
C. Hellier  
J. Horvath  
J. McClintock  
R. Rothschild  
R. Sunyaev

[www.das.inpe.br/school](http://www.das.inpe.br/school)



Ministério da  
Ciência e Tecnologia







## São José dos Campos (SJC)



With an estimated population of 589.000 inhabitants in 2004, SJC is, presently, the largest and most important city of the Paraíba Valley, in the northeastern part of São Paulo state. Its area was first occupied in 1590 by a cattle farm, where today is the borderline of São José dos Campos and Jacarei cities. It received the status of town in April 22, 1864 and received its present name in 1871.

SJC is one of the largest industrial and technological centers of the country and the home of well known research centers, such as the Instituto Nacional de Pesquisas Espaciais (INPE), the Comando-Geral de Tecnologia Aeroespacial (CTA), the Instituto Tecnológico da Aeronáutica (ITA), the Universidade do Vale do Paraíba (UNIVAP), and the Universidade Estadual Paulista "Julio de Mesquita Filho" (UNESP). São José dos Campos is also the home of EMBRAER (Empresa Brasileira de Aeronáutica), the 3rd largest aircraft company in the world, the largest and second oldest GM (General Motors) plant in Brazil, started 1958, and many other technological and electronics industries, totaling more than 700 companies.

Due to its privileged geographical position, between the mountain chains of Mantiqueira and Serra do Mar, SJC is very close to excellent leisure opportunities at the beach or up in the mountains. It is located between the metropolitan areas of Rio de Janeiro, 300 km North, in Rio de Janeiro state, and São Paulo (80 km South), the two largest consumption and production centers in the country.

How to get to SJC from São Paulo International Airport (Guarulhos)

By Car

From São Paulo International Airport to São José dos Campos take the Rodovia Presidente Dutra (Highway São Paulo-Rio de Janeiro. Distance: 79 Km = 50 Miles) or take the Rodovia Ayrton Senna (Rodovia dos Trabalhadores), drive 65 km and then merge to Rodovia Presidente Dutra driving more 23 km until São José dos Campos-SP (total of 88 km).

By Bus - Company Pássaro Marrom

Telephone numbers: (011) 6445-2505, 6445-3783 and 6445-3811  
(012) 3921-9892

Place:

Terminal of Passengers 1 - wing A - Arrival Floor

Terminal of Passengers 2 - wing D - Arrival Floor

Schedules of exits from the Airport to São José dos Campos:

08:00 - 13:00 - 17:15 - 22:00

Schedules of exits from São José dos Campos to the Airport:

06:30 - 10:30 - 15:30 - 20:00

Ticket Price: R\$ 15,00 = US\$ 7,00

By Taxi - Special Taxis

Telephone Number: (011) 6440-7070.

Place:

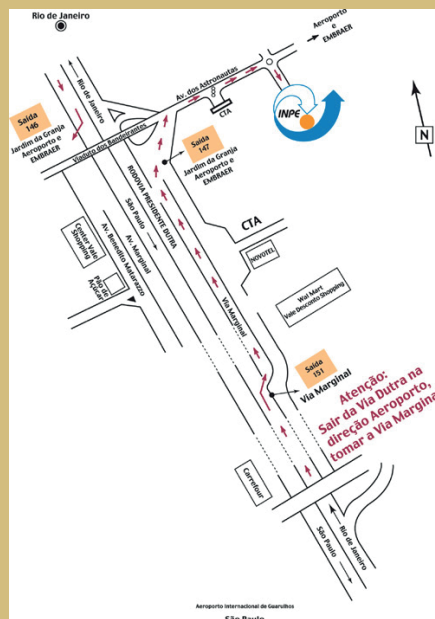
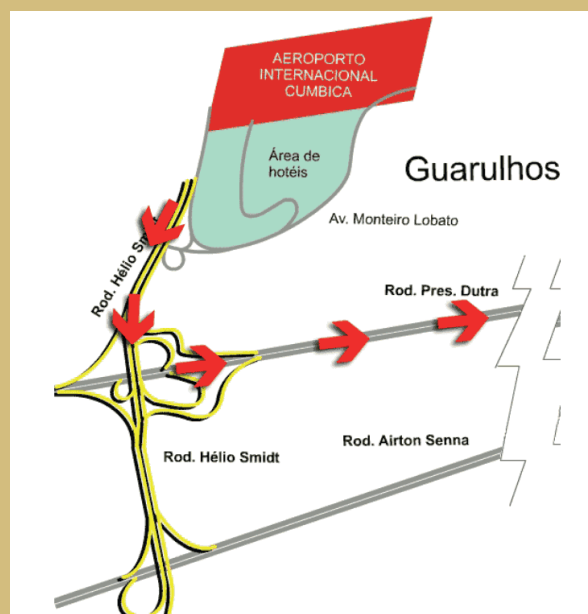
Terminal of Passengers 1 - wing B - Arrival Floor

Terminal of Passengers 2 - wing C - Arrival Floor

Service: 24h00.

Estimated Price: R\$ 200,00 = US\$ 90,00

See the road maps



## Region Main Attractions

### São José dos Campos

#### Parque da Cidade (City Park)

Former house of the Olivio Gomes family. The architectonic design is signed by Rino Levi and landscaping is by Roberto Burle Marx. The park has a great nature area, lake and artificial island, besides tracks for hiking.

#### Santos Dummont Park

Located in the neighborhood of Vila Adyana, close to downtown São José dos Campos, the park has fish-breeding lakes and lots of birds and has 2 elementary schools. The park houses a unit of the third prototype of the Bandeirante airplane, used by the old National Aeronautics and Space Commission, presently, INPE - National Institute for Space Research. Its located on Rua Eng. Prudente Meirelles de Moraes, 1000.

#### Banhado (Marsh)

The marshes of São José dos Campos are one of the most beautiful sights of the city, a true postcard. Its green area can be seen form many sites. Locals like to enjoy sunsets there.

