Tópicos en Astrofísica
Close binary stars

Profesor/Professor: Mónica Zorotovic + Claus Tappert + Maja Vuckovic
Horario/Schedule: Lunes y Jueves 12:00 - 13:30, sala de reuniones IFA A
Inicio/Starting date: Semana del 10 de agosto 2025
Cupo/Capacity: 4 postgrado + 3 pregrado
Pre Requisitos/Prerequisites: Deseable, manejo del código de evolución estelar MESA (si no lo ha usado se proveerá material online, incluídos videos, para aprender a usarlo).

Objetivo/Objectives: This course provides a comprehensive understanding of binary star systems, focusing on their formation, evolution, and observational characteristics, focusing on close systems with compact objects. The course also covers the observational techniques and analytical methods to derive orbital parameters and study time-domain data. Finally, students will also learn the basics of using the binary module of the stellar evolution code MESA for a short personal project.

Evaluaciones/Grading
- 25% presentation Part 1
- 25% presentation Part 2
- 25% small homework Part 3
- 25% MESA Project

PROGRAMA/PROGRAM

PART 1 (Mónica Zorotovic)

Introduction

- History
- Formation of multiple systems
- Statistics and initial parameter distribution
- Classification based on observational characteristics
- Newton and Kepler's laws
- Effects of tides: circularization and synchronization

Mass Transfer

- The Roche model and Roche lobe overflow
- Classification of close binaries based on the Roche model
- Types of mass transfer
- Formation of close compact binaries: the common envelope phase
- AML in close compact binaries: Magnetic braking, gravitational radiation

PART 2 (Claus Tappert)

Binaries with Compact Objects

- Compact objects
- Cataclysmic variables
- Novae
- Accretion
- X-ray binaries
- SN Ia

PART 3 (Maja Vuckovic)

Binaries with Compact Objects

- Hot subdwarf binaries

Observables & Observational Properties

- Observing techniques and derivation of orbital parameters
- Time domain and frequency analysis:
  - Fourier transform
  - Lomb-Scargle fitting
  - Period 04

PART 4: Binary Simulations

- MESA binary modules
- Personal project

Referencias bibliográficas/Bibliographic references
- An Introduction to Close Binary Stars (R.W.Hilditch; Cambridge University Press)
ISBN 0-521-79800-0
- Interacting Binary Stars (J.E.Pringle and R.A.Wade; Cambridge University Press)
ISBN 0-521-26608-4
- Evolutionary Processes in Binary and Multiple Stars (P.P.Eggleton; Cambridge University Press)
ISBN-10 0-521-85557-8 / ISBN-13 978-0-521-85557-0
- Cataclysmic Variable Stars: How and Why they Vary (2001, Hellier, C., Springer)
ISBN-13:978-1852332112
- Classical Novae (2008, Bode, M.F. & Evans, A. Cambridge University Press)
ISBN-13: 978-0521843300
- Other online resources will be given in pdf