Vybrané kapitoly z astrofyziky

The Black Hole Accretion

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Subject: Elementary aspects of accretion theory in astrophysics, including some advanced issues

Code: NAST021, "Selected Chapters in Astrophysics"

Place: Faculty of Mathematics and Physics, Charles University, Lecture Hall T1 (MFF UK, Praha-Troja)

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First lecture: 1st October 2009, T1, 14:00

Summary

I will describe the main results of the theory of black hole accretion.

A fairly complete description includes all classical results. Namely: the Balbus-Hawley theory of turbulent stresses; the Shakura-Sunyaev accretion disc; Polish doughnuts, ion tori, slim discs, and `adafs'; disco-seismology and the Papaloizou-Pringle instability – as well as recent developments in calculating spectra by advanced ray-tracing.

I do not assume any detailed knowledge of general relativity or radiative processes. I will introduce all the necessary physics step by step, in a way that (I hope) will be helpful for beginners and not boring for experts.

1. Basic physics

Einstein's theory of (strong) gravity. Symmetries. Killing vectors. Black holes. Kerr geometry. Trajectories of particles and photons. Circular orbits. Kepler and epicyclic frequencies. (Magneto) hydrodynamics, turbulence, dissipation. Optically thick and optically thin radiative processes.

2. Thick discs

Motivation for Paczynski's approach. Models of the von Zeipel fluid tori. Funnels. The Roche lobe and the inner edge boundary condition. Polish doughnuts and ion tori. Astrophysical applications: spectra, the black hole shadow.

3. Thin discs

General form of mass, momentum and energy conservation. Expansion of conservation equations in "cos theta". The Shakura-Sunyaev simplifications and trivializations. The Shakura-Sunyaev flux formula.

4. Slim discs and *adafs*

Advection. Inner edge, eigen-value problem, sonic point. Most recent models of slim discs and adafs.

5. Non-stationary accretion

Dynamical, thermal and viscous stability. General Lagrangean approach to stability. Thin discs: disco-seismology. Thick discs: Papaloizou & Pringle. Applications to quasi-periodic oscillations.

Extra

Unsolved problems in black hole accretion theory.
