UNIVERSITÉ DE LYON

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CENTRE DE RECHERCHE ASTROPHYSIQUE DE LYON

English below

Accrétion and écoulement par un trou noir dans les Microquasars

Laboratoire : Centre de Recherche Astrophysique de Lyon – UMR 5574
Directrice : Laurence Tresse
https://cral.univ-lyon1.fr/

Directeur de thèse : Rolf WALDER, professeur ENS-Lyon

Adresse électronique et téléphone : Rolf.Walder@ens-lyon.fr , ++33 (0)4 7272 8916

Contexte et Description du projet :

Microquasars are accreting stellar mass black-holes bound in a binary star system. Mass is transferred from the companion star to the black hole, either by Roche-lobe overflow or by accretion of mass from the stellar wind of the companion. In these objects, outflow is intimately linked to accretion. On the one hand, the outflow contributes to remove the excess of angular momentum of matter in the accretion disk, on the other hand the matter falling into the gravitational well powers a relativistic jet.

The formation of the jet from the accretion disk is still not well understood. Observations suggest that there are at least two different accretion regimes, called *high-soft* and *low-hard* state. The high-soft state is luminous with a soft (~1 KeV) thermal X-ray spectrum exhibiting a high-energy power law tail. Jets are weak or totally absent. Low-hard states show a much harder, but less luminous spectrum. It is dominated by power-laws pointing to a non-thermal origin of photons. These photons may be produced in a hot corona surrounding the accretion disk or the black hole or, alternatively, by scattering on accelerated particles in the jet.

There remain open questions in this picture, in particular regarding the origins of the transition between the two states, the mechanisms accelerating the jet, and the dependence of the jet power and internal structure on the accretion regime. Remains also the question of the acceleration of particles to energies far beyond the thermal energy of the plasma. This may be due to stochastic Fermi-acceleration in internal shocks of the jet or to magnetic reconnection events similar as those occurring in the corona of our sun, only at much higher energies.

The PhD student will use sophisticated general-relativistic MHD codes to simulate such systems. Using adaptive mesh techniques, the simulations shall covering all spatial and temporal scales, from the binary environment down to the horizon of the black hole. The main goal is to improve the understanding of general relativistic effects, the launch of the jets, and the origins of the state transitions. Cross-scale simulations have never been done in microquasars and similar systems. We expect from this new approach a deeper understanding of microquasars as a whole, by putting together different views on such systems explored in the last decade.

The PhD student will have to adapt existing codes by adding non-ideal effects like resistivity and Hall terms and by adding some radiative effects. Our team has a strong expertise in numerical modeling and will support the student in this task. The student will then perform global simulations of different microquasars, of the accretion flows and the jet and their mutual interplay. She/he will analyze and visualize this simulation data and prepare them for publications. The student will work in a lively team

with a lot of connections worldwide – to theoreticians and observers, to plasma-physicists, and to numerical experts.

Prerequisites: good knowledge of fluid mechanics and general relativity, a broad background in astrophysics, strong numerical skills. Some knowledge in the theory of radiative transfer and of plasma physics is a plus.

Date de début de thèse : septembre 2017

Financement : ORIGINE : ED ; FINANCEMENT PROPOSÉ

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Accretion and Outflows by Black Holes in Microquasars

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Institute: Centre de Recherche Astrophysique de Lyon – UMR 5574
Director: Laurence Tresse,
https://cral.univ-lyon1.fr/

PhD supervisor: Rolf WALDER, professor ENS-Lyon

Email address and phone number: Rolf.Walder@ens-lyon.fr , ++33 (0)4 7272 8916

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Starting date: September 2017

Funding: ORIGIN (ED / OTHER), PROPOSED OR FUNDED