PhD research proposal at the Astronomical Observatory, Jagiellonian University

I am looking for an ambitious person to start doctoral studies and cooperation on a scientific project entitled *Dynamical evolution of radio galaxies – probing the past of a central supermassive black hole through analysis of associated large-scale radio emission.*

The person selected by me and meeting the conditions and accepted on the principles of the exam/ competition for the PhD School of Formal and Natural Sciences of the Jagiellonian University will conduct research consisting analysis of observational data (mainly radio and optical) on active galaxies and computer modeling of physical processes occurring in radio galaxies (some details given below).

The candidate is required to have: very good astrophysical knowledge at the level of master's studies, programming skills (C ++, Fortran, symbolic calculation packages), advanced knowledge of optical and radio (AIPS, CASA) packages to reduce astronomical data. In addition, the candidate should be communicative and creative, and should have the ability to work independently and in a team.

Required documents:
(1) a CV including information about the scientific achievements to date,
(2) a cover letter describing skills useful in the project,
(3) a copy of the M.Sc. Diploma and all exam grades earned in the course of M.Sc. studies,
(4) a reference letter from a senior scientist.

Admission rules for the doctoral studies in astronomy at the Jagiellonian University are given at:
http://www.oa.uj.edu.pl/Studia_Doktoranckie/stopien3.en.html

Submissions and inquiries should be sent via e-mail to the following address:
marek.jamrozy@uj.edu.pl

Kraków, 2019 May 2nd.

dr hab. Marek Jamrozy

"Dynamical evolution of radio galaxies – probing the past of a central supermassive black hole through analysis of associated large-scale radio emission"

Recently, the black holes of small, starlike, masses got famous following direct detection of gravitational waves generated during mergers of such objects. There is evidence (though only indirect one) that there is a very massive black hole in the centre of every galaxy. Our Galaxy has a black hole of several million solar masses in its central part. This massive object in the distance of about 26 thousand light-years from us, is rather quiescent, since there is not enough matter in its neighbourhood that could fall into it. However, one in about 100 galaxies contains an untypical black hole. Particular character of those galaxies consists in the fact that they can be observed not only in the optical one but in the radio range as well. Astronomers are aware of this type of objects – called radio galaxies – already for more than 60 years. The mechanism of their formation involves a rotating supermassive (of several milliard solar masses) black hole surrounded by a disk of accreting matter of typical size of the Solar System in its central region. From those relatively small objects, matter, energy, and magnetic field can be transferred in the form of narrow relativistic jets of charged plasma to very large distances, much exceeding the very size of a given galaxy (see Fig. 1, left panel).

Our knowledge of radio galaxies – those giant cosmic accelerators of charged particles – has been considerable altered in the last years. Until quite recently, the prevailing view was that the central black hole's activity can last on average several dozen million years, which is little as compared to the ages of galaxies (several milliard years). However, it has just turned out that contingent on the conditions in the vicinity of a black hole, its nuclear activity can switch on and off once and again. The information of such behaviour is carried out and preserved in growing regions of charged particles emitting radio waves. These formations have mostly an axial symmetry, while some of them are much warped. We cannot know for sure but it seems that the deformation is due to very massive companions present in the immediate vicinity of the supermassive black hole. It is their gravitational interaction that causes the black hole to wobble, and matter outflows become twisted instead of straight ones (see Fig, 1, right panel).

These are such peculiar objects that we would like to probe through analysis of their large-scale radio emission. Our investigations are going to contribute to understanding the mechanism to form supermassive black holes as well as the modes of generating enormous amounts of energy in the centres of some galaxies.

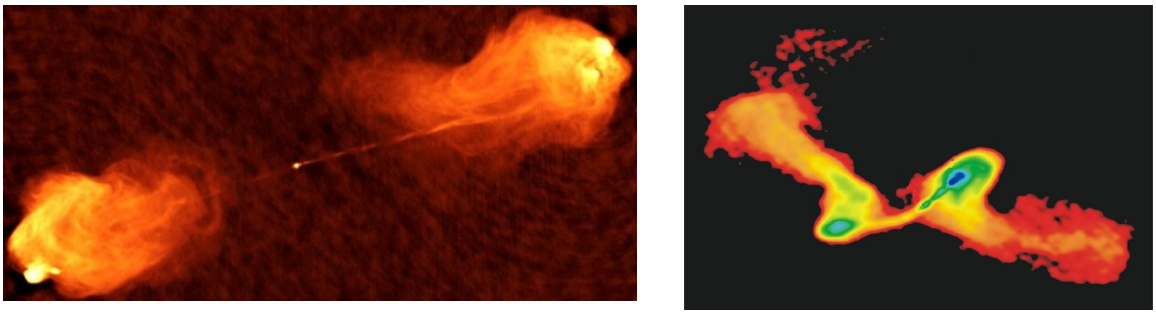

Figure 1. Left panel: Structure of a typical radio galaxy showing a bright compact point-like object in its centre (immediate vicinity of a supermassive black hole), from which come out two narrow coaxial jets of charged particles powering extensive lobes of radio emission that grow with time. Right panel: a twisted radio galaxy, which peculiar structure is related to the wobbling – like a children's spinning top – central supermassive black hole.