Astrophys Space Sci (2012) 337:703–710
DOI 10.1007/s10509-011-0894-4

ORIGINAL ARTICLE

Vertically self-gravitating ADAFs in the presence of toroidal magnetic field

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Received: 17 August 2011 / Accepted: 13 October 2011 / Published online: 4 November 2011

Abstract Force due to the self-gravity of the disc in the vertical direction is considered to study its possible effects on the structure of a magnetized advection-dominated accretion disc. We present steady-sate self similar solutions for the dynamical structure of such a type of the accretion flows. Our solutions imply reduced thickness of the disc because of the self-gravity. It also imply that the thickness of the disc will increase by adding the magnetic field strength.

Keywords Accretion · Accretion flow · Self-gravity

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1 Introduction

There has been rapidly progress over the past three decades towards a better understanding of the accretion processes in astrophysics, in particular accretion discs around compact objects or even black holes (see reviews by Narayan et al. 1998; Kato et al. 2008). Black hole accretion is one of the most important ingredient when considering astrophysical scenarios of galaxy/quasar formation. Current belief is that there are two sites where an accretion disc around a black hole can be found: In close binary systems called X-ray binaries (XBs), and at the center of the galaxies. The birth of modern accretion disc theory is traditionally attributed to the original model presented by Shakura and Sunyaev (1973). This standard geometrically thin, optically thick accretion disc model (SSD) can successfully explain most of observational features in active galactic nuclei (AGNs) and X-ray binaries. In the standard thin disc model, the motion of matter in the accretion disc is nearly Keplerian, and the viscous heat in the disc is radiated away locally. An alternative accretion disc model, namely, the advection-dominated accretion flows (ADAFs), was suggested for the black holes accreting at very low rates (Ichimaru 1977; Narayan and Yi 1994).

In some of the scenarios of structure formation in astrophysics, in particular those related to the formation of the stars or galaxies, self-gravity of the system may play a vital role. Formation of an accretion disc, as one stage of the structure formation, is an important part of any theory in this field. However, in the standard accretion disc model, the effect of self-gravity in the vertical or radial direction of the disc is neglected for simplicity and the disc is supported in the vertical direction only by the thermal pressure. Although in some of the accreting systems it is a reasonable assumption, there are situations, in which one can hardly