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Editorial

Editorial for the Special Issue "Accretion Disks, Jets, Gamma-Ray Bursts and Related Gravitational Waves"

Banibrata Mukhopadhyay

Department of Physics, Indian Institute of Science, Bangalore 560012, India; bm@iisc.ac.in

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The present Editorial introduces the Special Issue dedicated by the journal Universe to the "Accretion Disks, Jets, Gamma-Ray Bursts and Related Gravitational Waves". The accretion flow is ubiquitous in astrophysics, which is the primary agenda of the Issue, particularly concerning black holes. Gamma-ray bursts are often argued to be the birth cry of black holes and, hence, naturally feature in the Issue. Finally, gravitational wave detections appear to offer a new window of Astronomy, namely Gravitational Wave Astronomy, which has been also touched upon by the authors in the Issue. All in all, we have a collection of seven articles, mostly by the leaders of the respective fields, contained within this Issue.

A black hole being black does not reflect any light and it is the underlying accretion disk which helps us identify it and its properties. Depending on X-ray emissions, the broad models of accretion disks are the following: (1) Geometrically thin and optically thick Keplerian accretion disk [1] explaining soft X-rays and high luminosities; (2) Geometrically thick optically thin sub-Keplerian and advective accretion disks [2–4], explaining hard X-rays and low luminosities; (3) Radiation trapped slim disks [5], which often argue for ultra-luminous X-ray sources (ULXs).

The Keplerian disk proposed by Shakura and Sunyaev [1] is often considered to be a standard disk. However, it is unable to explain hard X-rays from accretion flows, even emissions from the center of our galaxy Sgr A*, particularly in the vicinity of the black hole. Moreover, it is inappropriate for ULXs unless the black hole mass is assumed to be higher than that of a standard stellar mass, i.e., intermediate mass. While by gravitational wave astronomy, intermediate mass black holes do not appear to be far reaching, the mass (M) scales inversely with the temperature: $T \sim M^{-1/4}$. Therefore, ULX spectra must exhibit low temperature than that inferred from stellar mass black hole sources, if they are intermediate mass black hole sources, which, however, is often not the case. Therefore, ULXs are argued to be a slim disk, when the accretion rate is super-Eddington, hence the radiation trapped flow is. Here, the contribution from Bozena Czerny steps in, who is one of the pioneers of the slim disk model. In her paper in this Issue [5], she revisits the slim disk model, its successes and caveats, and how to possibly refine the model in order to explain data adequately.

Dynamics of accretion disks around a black hole and a neutron star are understood to be determined by magnetic fields. If the field is weak, it is the magnetorotational instability (MRI) [6–8] which develops the turbulence and transport of matter in the disk flow, when molecular viscosity is negligible therein and unable to explain observed luminosity. With increasing field, MRI becomes sluggish and any transport must be via large scale strong magnetic fields or any other magnetic instability. There is evidence which argues that the field in an accretion disk around a, e.g., stellar mass black hole could be as high as a million Gauss or more. In order to understand such a magnetically arrested system, Gennady Bisnovatyi-Kogan contributes his work in this Issue. He has discussed how the topic got developed since its initiation in early 1970s to what it is today [9], when it is being proven by numerical simulations.

Accretion disks are often associated with powerful, highly collimated jets. While the origin of jets and underlying emission mechanism are not completely uncovered yet, it is generally believed that their formation, particularly launching, is a magnetic process. There are two possibilities: a general relativistic magnetically processed Blandford–Znajek mechanism [10], and a magnetohydrodynamical accretion disk-induced Blandford–Payne mechanism [11]. The former is more like the magnetized Penrose Process [12], where the black hole has to be spinning. To enlighten the jet issues, theoretically and by numerical simulations, Arman Tursunov and Naresh Dadhich [13] and Christian Fendt [14], respectively, contribute in this Issue.

Gamma-ray bursts are often argued to be the birth cry of black holes ([15], also see [16]). However, the exact related physics are still under dispute. One thought is that during the core-collapse of massive stars forming a black hole or a neutron star, a disk of life-span of a few tens of seconds forms out of the stellar mantle of the collapsing star, called a collapsar disk or supernova disk [17]. Subsequently, this collapsar disk produces jets manifested as a gamma-ray burst. However, Jorge Rueda, Remo Ruffini and Y. Wang looked at the problem from a different angle and argued for the connection of long duration gamma-ray bursts with their short duration counterparts [18]. They elaborate their idea and related physics in detail in this Issue.

Since the direct detection of gravitational waves (GW) in 2015, GW Astronomy seems to be becoming a new branch of astronomy, as a counter part of X-ray, gamma-ray, radio, etc., astronomies. It seems to already be a new window to confirm many new astrophysical features, e.g., the existence of intermediate mass black holes. In this connection, a work led by Achamveedu Gopakumar has been reported in this Issue centering around the bright blazar OJ 287 and its massive binary black hole [19]. Note that OJ 287 is the best-known candidate for hosting a nanohertz GW-emitting supermassive binary black hole. The observations of three predicted impact flares of OJ 287 open up the possibility of using this binary black hole system to test general relativity in a hitherto unexplored strong field regime.

There is an interesting additional paper on hot accretion flow in this Issue [20]. All the above papers, though limited in number, make a compact set of important work, which we believe to be important literature in the astrophysics community. We end by encouraging the readers and potential authors to dive into the topic and contribute to future Issues of the journal, for the continued development of this rich field of high-energy astrophysics.

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