
Compact jets and black hole formation

Felix Mirabel^{*1,2}

¹Instituto de Astronomía y Física del Espacio (IAFE) – Ciudad Universitaria. Buenos Aires, Argentina

²Service d'Astrophysique (SAP) – Commissariat à l'énergie atomique et aux énergies alternatives :
DRF/IRFU, Université Paris-Saclay – Service d'Astrophysique, CEA-Saclay, DRF/IRFU/SAP, Bât.
709, L'Orme des Merisiers, F-91191 Gif-sur-Yvette Cedex, France, France

Abstract

I will start underlying the importance of stellar black hole (BH) formation in Cosmology and Gravitational Wave Astrophysics.

It is believed that BHs are formed in two different ways: Either a massive star collapses directly into a BH without a supernova (SN) explosion, or an explosion occurs in a proto-neutron star, but the energy is too low to completely unbind the stellar envelope, and a large fraction of it falls back onto the short-lived neutron star (NS), leading to the delayed formation of a BH. Because NSs may have runaway velocities of up to 1000 km/s, probably due to natal kicks, in models of BH formation natal kicks in BHs have also been invoked.

Using VLBI observations of BH compact jets the parallax distances and proper motions of BH-XRBs can be determined, and together with the radial velocities, their kinematics in three dimensions can provide clues on the formation of BHs, and in particular, on putative BH natal kicks.

X-ray binaries may be formed in different environments and their runaway velocities be caused by a diversity of physical mechanisms, I will show that so far there is no solid evidence that the runaway velocities of certain black hole X-ray binaries are due to natal kicks on the BH in the X-ray binary. However, VLBI of the compact jets in Cygnus X-1 and GRS 1915+105 provide evidence for BH formation by direct collapse with no energetic natal kicks, which has an impact on Cosmology and GW Astrophysics.

Keywords: Jets, Black Holes, Natal Kicks

*Speaker