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Investigating Black hole formation using VLBI

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Even though the first black hole (BH) was detected decades ago, the mechanism by which BHs form is not observationally well constrained. Theoretical models suggest that BHs are born when a massive star dies, either with or without a supernova explosion. BHs born with a supernova explosion should get strong natal kicks, whereas direct collapse BHs do not incur
such a kick. We are measuring the proper motions (few mas/yr) of BH X-ray binary (BHXB) systems during their hard states by using Very Long Baseline Interferometry (VLBI) networks all over the globe, including the European VLBI Network. Combining the proper motion with the radial velocity and distance to the system, the full three-dimensional space velocity can be obtained. The system can then be traced back in time through the Galactic potential to estimate the magnitude of the natal kick that could have put the binary system into its Galactocentric orbit. We are also folding into our analysis the few BHXB systems that are optically bright enough in quiescence for their proper motion to be measured by Gaia. A strong natal
kick could unbind a binary system present in the field or result in ejection of BHs from globular clusters, both of which decrease the probability of formation of a BH-BH binary. Thus, the BH natal kick distribution directly affects the predicted rates of BH-BH mergers. We aim at increasing the sample set of estimated natal kicks to obtain an observationally constrained
natal kick distribution. In this talk, I will present the natal kick analysis of several BHXB systems, including one system that was observed using the EVN (Swift J1753.5-0127).