Modelling X-ray beacons in curved space time

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In accreting X-ray pulsars, strong magnetic fields funnel matter onto the magnetic poles of neutron stars forming localized emission regions for beamed X-rays. As the pulsar rotates, very characteristic periodic patterns, so called pulse profiles, are observed, which show a broad range of complexity. Because of the extreme compactness of neutron stars, investigating the information contained in these profiles requires to account for general relativistic effects, like light bending, which can lead to complex and non-intuitive connections between the observed pulse profiles and the intrinsic geometry.

We have developed a flexible ray tracing code, which calculates the observed time and energy dependent flux for arbitrary geometry and emission patterns of the emission regions. We present the result of a simultaneous fit of the energy-resolved pulse profiles of 4U 1626-67 (NuSTAR) based on an empirical emission pattern applied to a common two column geometry. We assume the emission pattern to be a mixture of Gaussian-like fan and pencil beam emission, which sufficiently describes the energy evolution of the observed pulse profiles.

Further we present a physical accretion column model combining the model from the simulations by Postnov et al. (2015) to obtain seed photon continua produced in the dense inner regions of the accretion column. In a thin outer layer these seed continua are imprinted with cyclotron resonant scattering features calculated using Monte Carlo simulations as described in Schwarm et al. (2017). From these emission patterns we derive the observed phase and energy dependent flux for different geometries using the relativistic ray tracing code and discuss the observational implications.