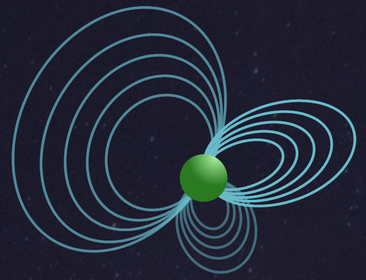
Decomposing X-ray Pulsar Profiles

A New Method

The pulse profiles of accreting X-ray pulsars depend on:

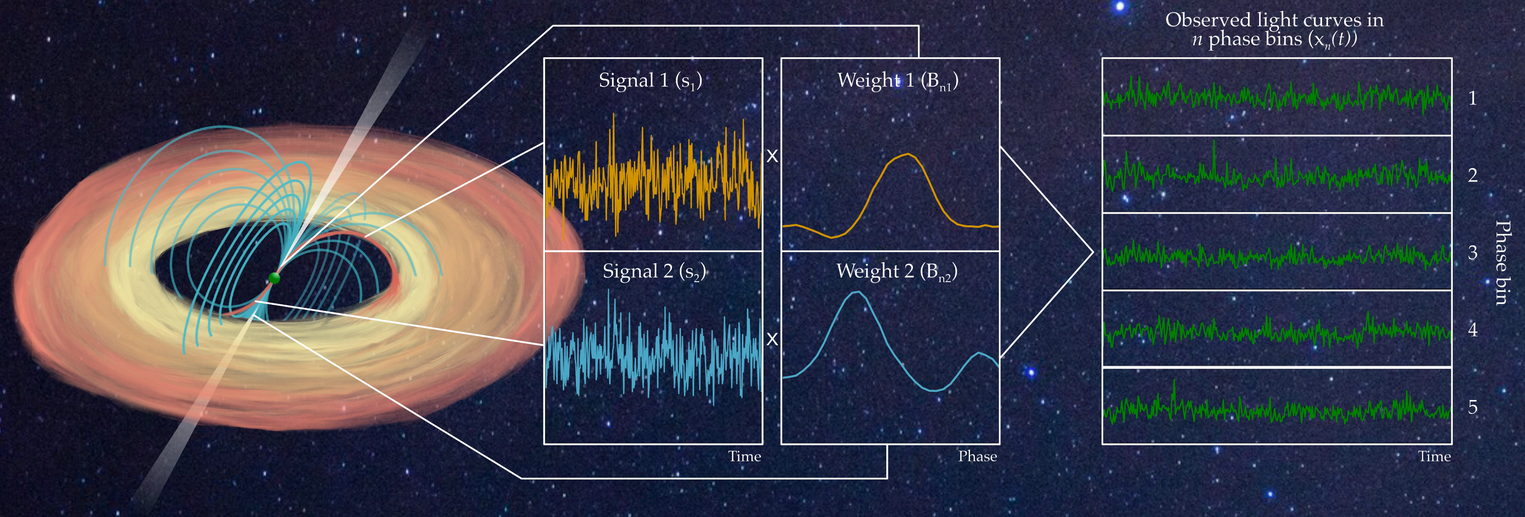
1. The geometric configuration of the system (magnetic obliquity, line of sight, …)
2. The magnetic field configuration (dipole, distorted dipole, …)
3. The anatomy of the emitting region (fan/pencil beam)
4. Light reflection and gravitational light bending.



At a given pulse phase, we can see a **mixture** of the emission of **both poles at the same time**. This can occur because of one or the combination of a number of phenomena, e.g. the type of accretion column (if present), gravitational light bending, beaming, reflection...

The problem is:

We still don't know the contributions of the individual poles and their intrinsic emission properties!



A fluctuating accretion rate leads to a uniquely variable emission of the two poles. We exploit this to **disentangle the contributions of the individual poles** using a blind source separation (BSS) method called non-negative matrix factorisation (**NMF**).

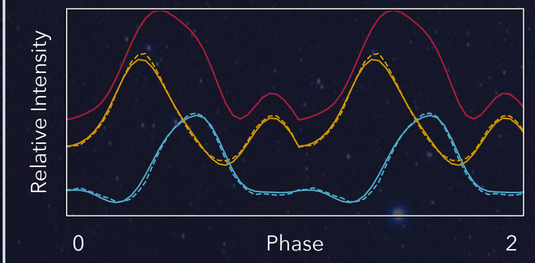
For this, we consider that the observed flux in any given pulse phase is a **mix** of the **two signals**, which are **weighted** by the **intensity** of the emission of each pole - the single-pole pulse profile.

Inga Saathoff
Victor Doroshenko
Andrea Santangelo

Institute for Astronomy and Astrophysics
University of Tübingen
Germany

saathoff@astro.uni-tuebingen.de

Simulation



Input weights/single-pole pulse profiles (solid blue and yellow) and the recovered weights (dashed).

We were able to recover the original profiles of the simulation well using the NMF method.

Observation (RXTE) of Cen X-3

The decomposition result using NMF show that the primary peak is composed of **two distinct peaks** of approximately **equal amplitude**. The two profiles are notably **asymmetric** in phase and the peaks are **narrow**.