EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN

MATHEMATISCH-
NATURWISSENSCHAFTLICHE
FAKULTÄT

HEA – High Energy Astrophysics: Data Analysis

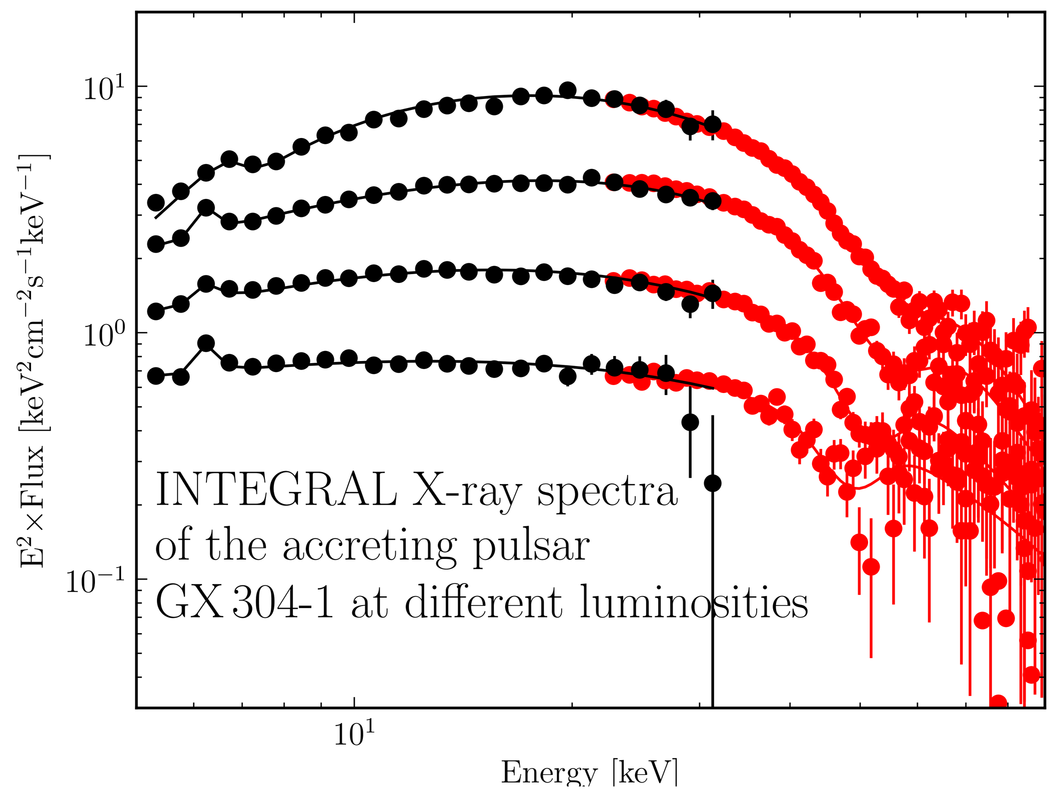
P. Bordas, Y. Cui, R. Doroshenko, V. Doroshenko, L. Ducci, D. Klochkov, C. Malacaria, B. Mück, D. Müller, S. Piraino, G. Pühlhofer, A. Santangelo, R. Staubert

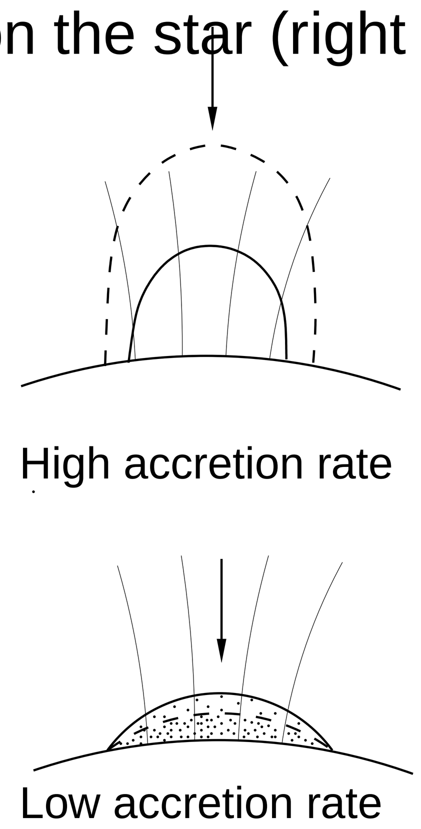
Institut für Astronomie und Astrophysik

X-rays from Accreting Binary Systems

The Tübingen HEA group studies accretion processes in Galactic binary systems that consist of a normal and a neutron star. Recent highlights include:

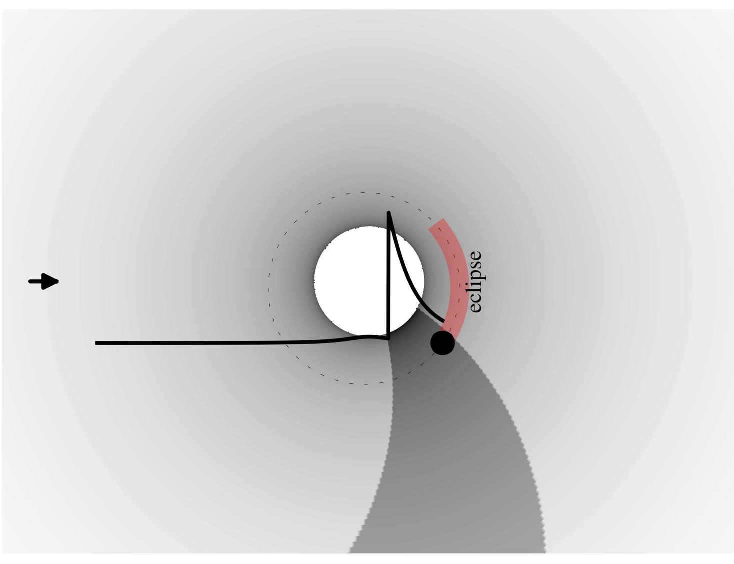
Accretion modes of X-ray pulsars: The luminosity dependence of the X-ray spectrum of accreting pulsars (left plot) allowed different accretion modes to be identified, corresponding to different configurations of the emitting structure on the star (right plots).

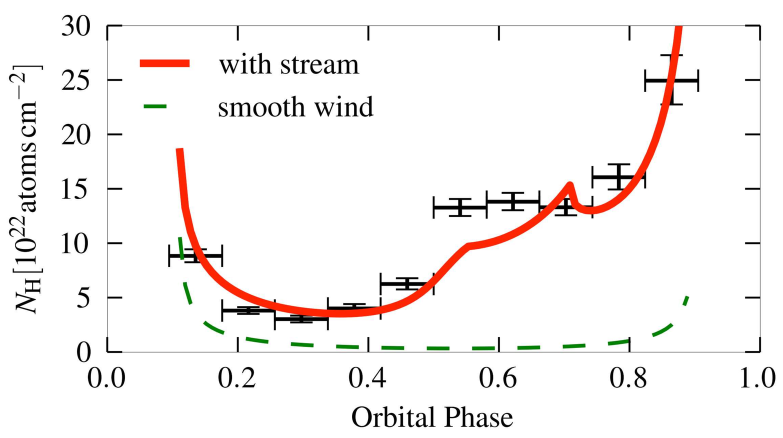




D. Klochkov, R. Staubert, A. Santangelo et al. 2012, A&A, **532**, 126
D. Klochkov, V. Doroshenko, A. Santangelo 2013, A&A **542**, 28

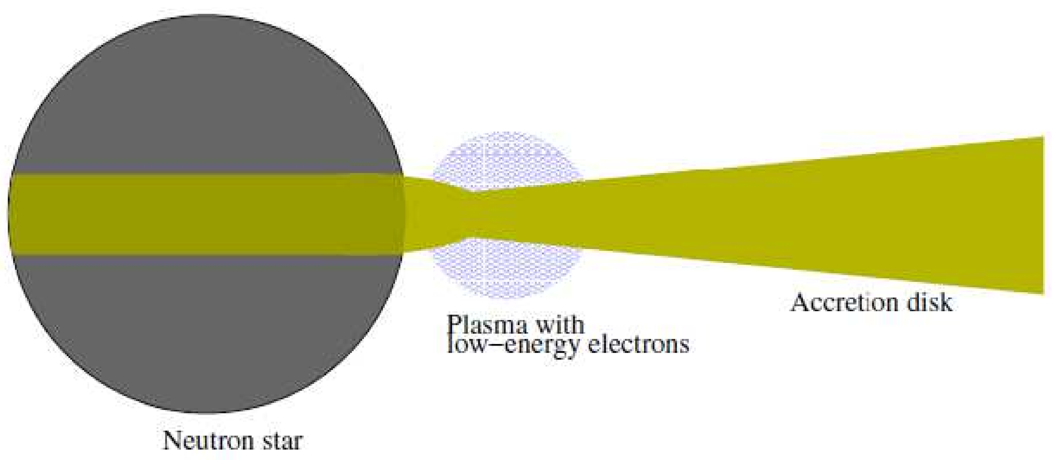
Stellar wind structure in Vela X-1: Using the spectral data from *MAXI* onboard ISS, we studied absorption of X-rays from the accreting neutron star by matter in the wind of the companion star in Vela X-1. The data reveal a stream-like photoionization wake region trailing the neutron star (the top picture). The dependence of the absorption column on orbital phase (black: the observations, red: the model fit) is shown in the bottom plot.

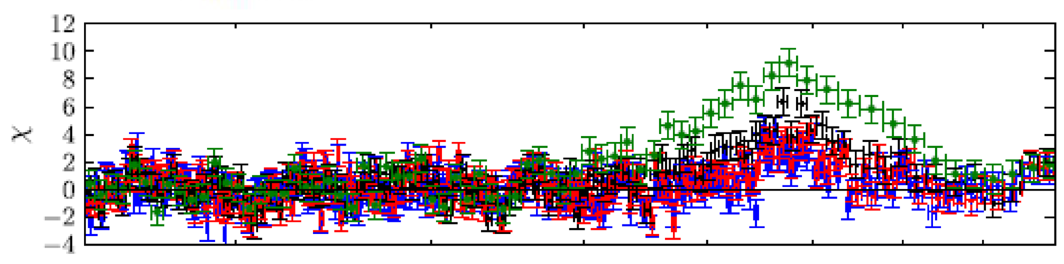




V. Doroshenko, A. Santangelo, S. Nakahira et al. 2013, A&A **554**, 37

Spectral study of the low-mass X-ray binary 4U 1735-44:



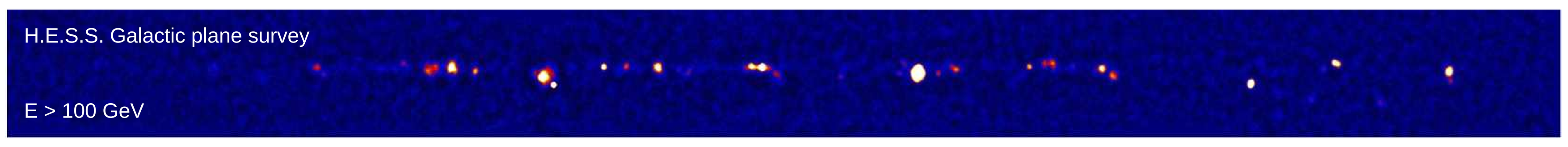


B. Mück, S. Piraino, A. Santangelo 2013, A&A **555**, 17

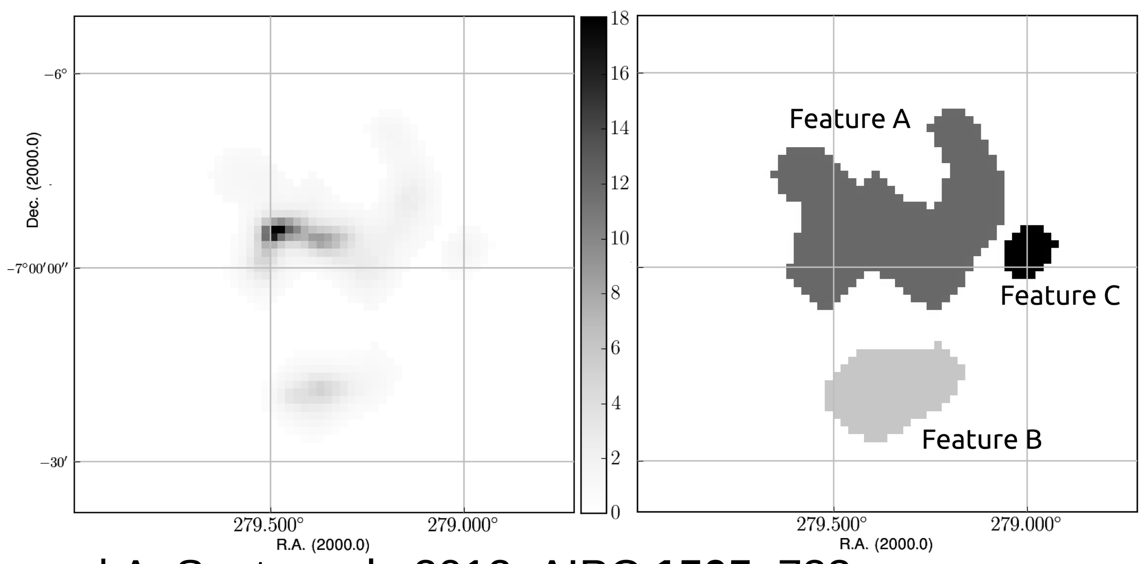
Modeling the source's X-ray spectra, we studied the geometry of the binary system (top plot), especially the inner edge of the accretion disk where the iron K_α line is formed. A part of the *XMM-Newton* spectrum with the line is shown on the bottom plot.

TeV gamma-ray sources in our Galaxy

Recent surveys of the Galactic plane with TeV Cherenkov telescopes have revealed a rich population of TeV sources. The work of the Tübingen HEA group focuses on the identification and characterization of such objects, using TeV data from H.E.S.S. as well as X-ray data.

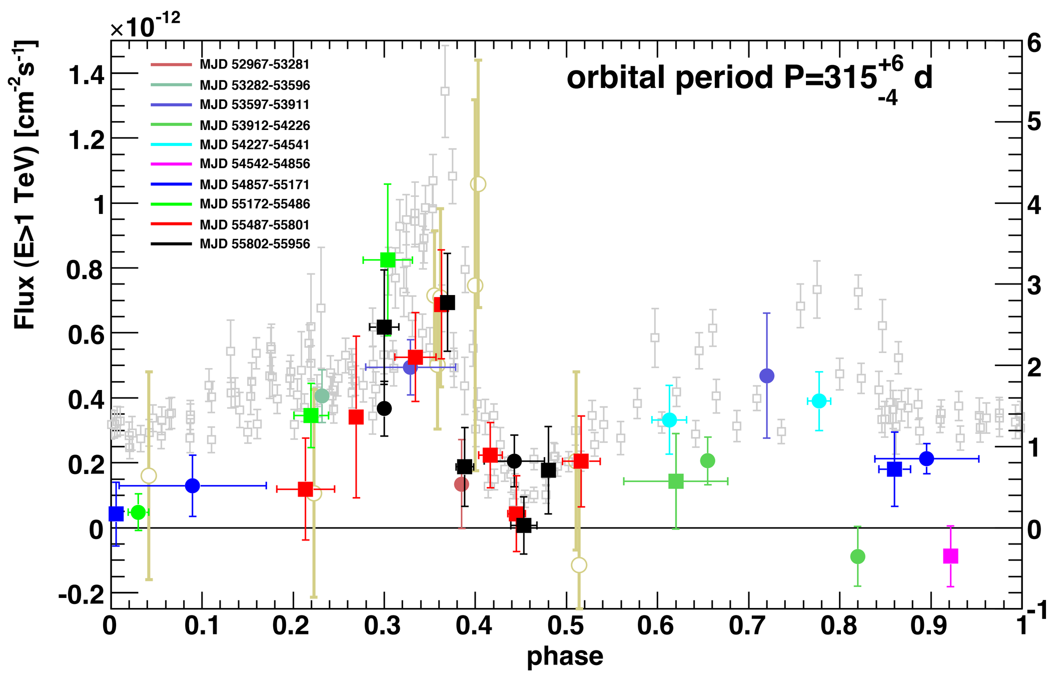


Identification of TeV sources: To identify the nature of the newly discovered TeV sources, we follow different research lines. One goal is to develop robust approaches to morphologically characterize the sources with a priori unknown shape. The figure shows a TeV sky map of the region around HESS J1837-069 (left) and a split into features, using an unbiased, a priori defined split algorithm (right).



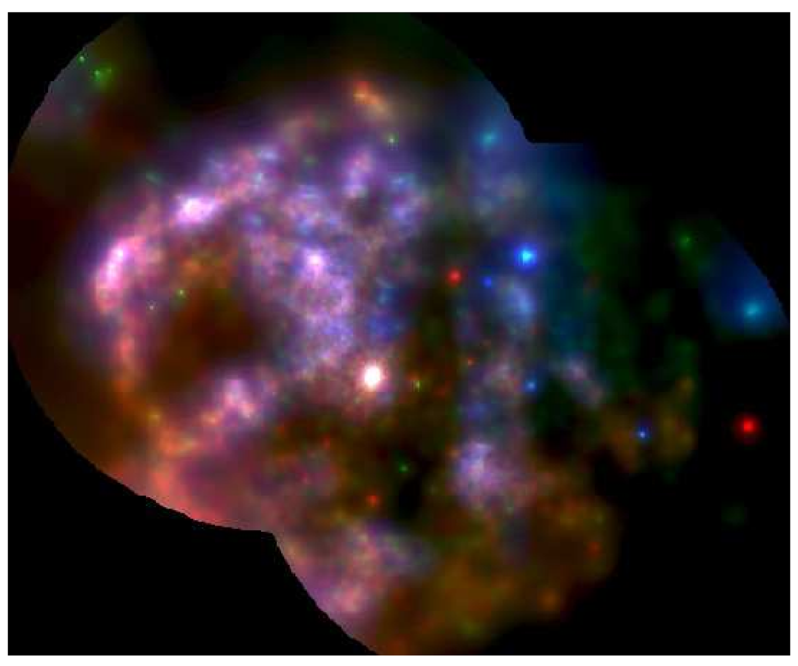
S. Schwarzburg, G. Pühlhofer, and A. Santangelo 2012, AIPC **1505**, 733

γ-ray binaries: A few TeV sources are identified as binaries, through their variability in TeV and other wavebands. The figure shows the TeV lightcurve of HESS J0632-057 from H.E.S.S. and VERITAS. Orbital parameters of the binary system are derived from X-ray and optical data. The TeV Galactic plane survey data are also analyzed for other new binary systems.



VERITAS and H.E.S.S. collaborations, in preparation.

Supernova Remnants:
HESS J1731-347 is the most recent TeV source identified as shell emission from a Supernova remnant. We are investigating the X-ray synchrotron emission of this remnant using *XMM-Newton* (see figure), *Chandra*, and *Suzaku* observations, to characterize the particle acceleration in the shocks.



The remnant hosts an X-ray emitting neutron star in its center. The X-ray data have been successfully used to constrain the chemical composition of the neutron star's atmosphere.

A. Bamba, G. Pühlhofer, F. Acero, et al. 2012, ApJ **756**, 149
D. Klochkov, G. Pühlhofer, V. Suleimanov, et al. 2013, A&A **556**, 41

Poster presented at
Waves and Particles: Multi-Messengers from the Universe
AG Annual Meeting, 24.-27.09.2013, Tübingen, Germany

University of Tübingen · Faculty of Science
Kepler Center for Astro and Particle Physics
Institute for Astronomy and Astrophysics