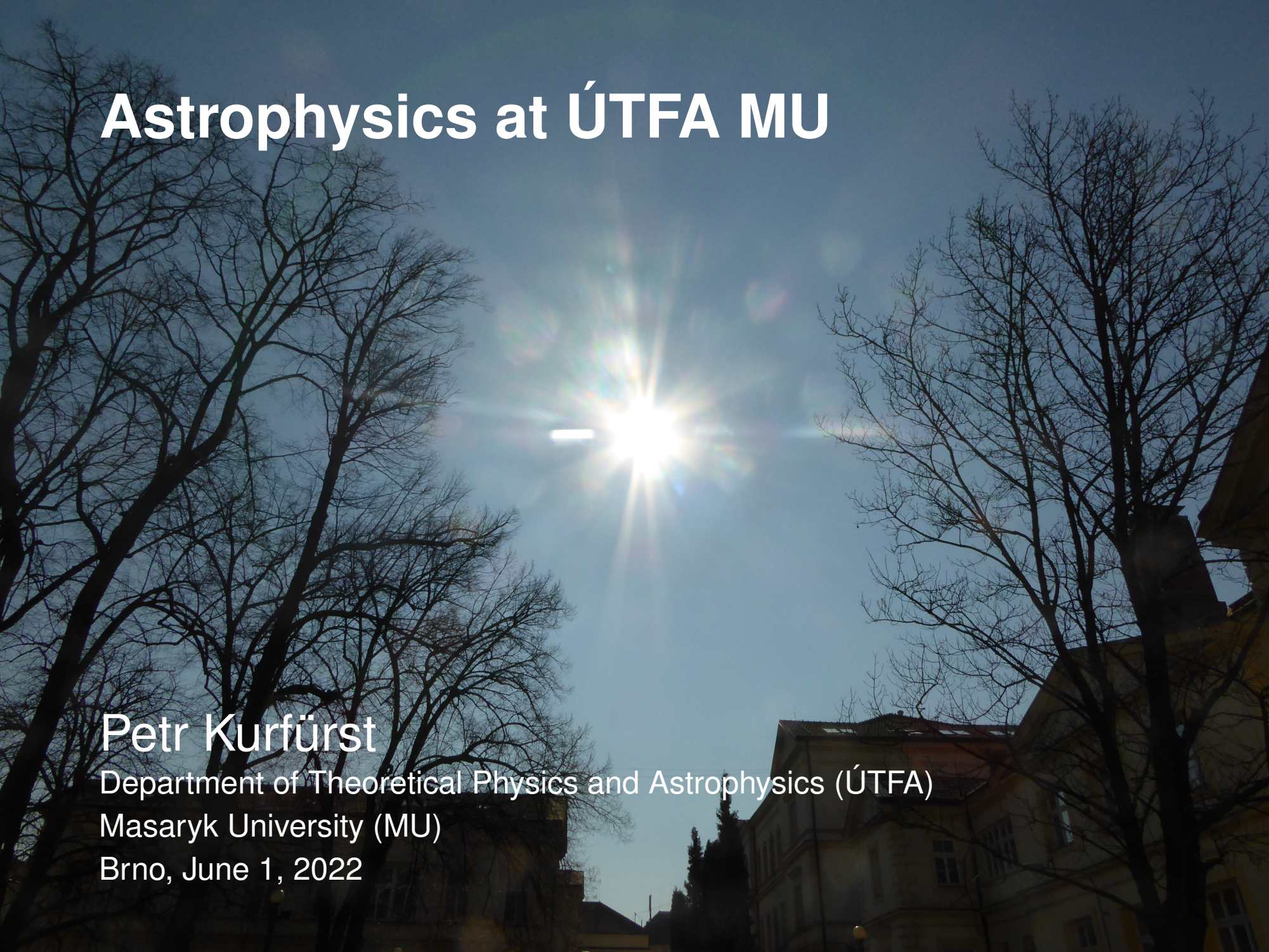


Astrophysics at ÚTFA MU

Petr Kurfürst
Department of Theoretical Physics and Astrophysics (ÚTFA)
Masaryk University (MU)
Brno, June 1, 2022

Department astronomers (except Norbi, Michal, and the other participants of the CPB meeting)

- **Zdeněk Mikulášek** - his field of research are variable stars, especially chemically peculiar stars. He is also the well-known and enthusiastic popularizer of astronomy and astrophysics.

- **Jiří Krtička** - focuses namely on stellar winds and circumstellar environment of hot stars. He also studies the chemically peculiar stars, planetary nebulae, and population III stars.

- **Vladimír Štefl** - studies cool stars (K and M type) . He is also the lifelong expert in the history and didactics of physics and astrophysics.

Department astronomers (except Norbi, Michal, and the other participants of the CPB meeting)

- **Miloslav Zejda** - focuses on variable stars, particularly on eclipsing binaries or RR Lyrae stars. For all types of variable stars he acquires own original photometric or spectroscopic data.

- **Ernst Paunzen** - studies variable and chemically peculiar stars as well as star clusters. He is the expert in spectral classifications, including the UV and NIR region. He also focuses on data mining, pipeline software, and virtual observatory.

- **Jan Janík** - experienced observer and data analyzer. He studies variable stars, chemically peculiar stars, eclipsing binaries, and open clusters.

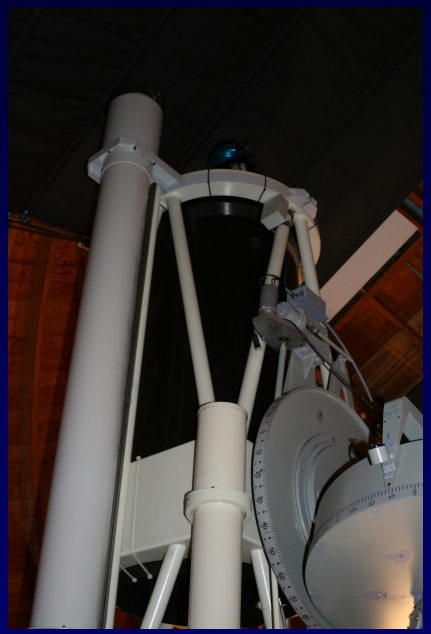
Observational facilities

- University telescope - Kraví hora (in the dome directly opposite the observatory)
- 60 cm mirror telescope, the largest in the former Czechoslovakia until the year 1967
- Newton's focus, equipped with a G2-4000 CCD camera with UBVRI filters
- Currently, multiple eclipsing stellar systems are observed there (e.g., the quadruple system V442 UMa)

- ASA Ritchey-Chrétien telescope f6.85 (will be installed at the end of 2022 at Ždánice observatory)
- 80 cm fully automated observatory telescope system with Nasmyth focus
- Will be used for photometry and spectroscopy

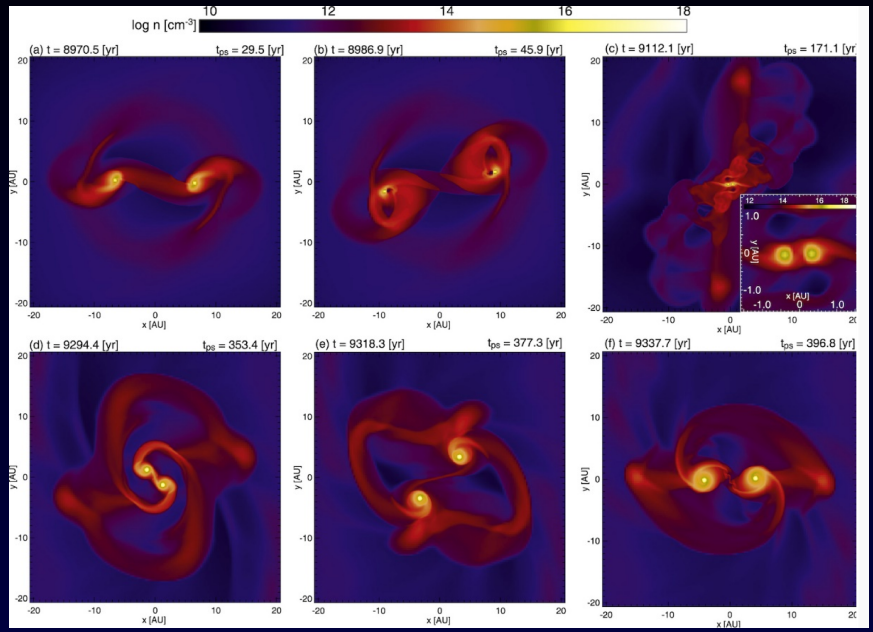
Observational facilities (used externally)

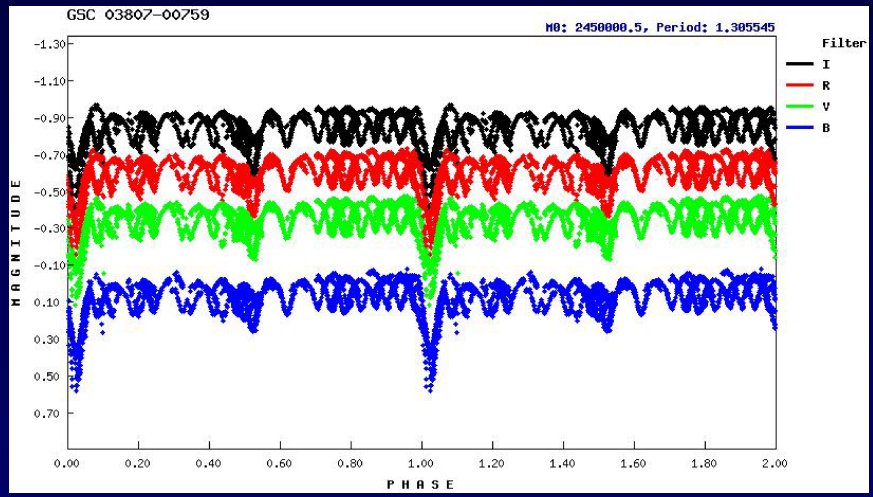
- Dk 154 telescope at La Silla
- 1.54-metre telescope, now equipped with the Danish Faint Object Spectrograph and Camera instrument
- In 2012 fully robotized and used for remotely controlled observations from our university site
- Currently used for observations of binaries (now also for the quadruples), open stellar clusters, and also for obtaining data for students' master and PhD theses
- Mt. Suhora (south Poland) 60 cm mirror telescope of the Cassegrain system
- Mainly used for photometric observations of binaries, chemically peculiar stars, open clusters, etc.
- Perek 200 cm telescope in Ondřejov - used for particular observational campaigns (photometry or spectroscopy), and several others...



Current observational objectives

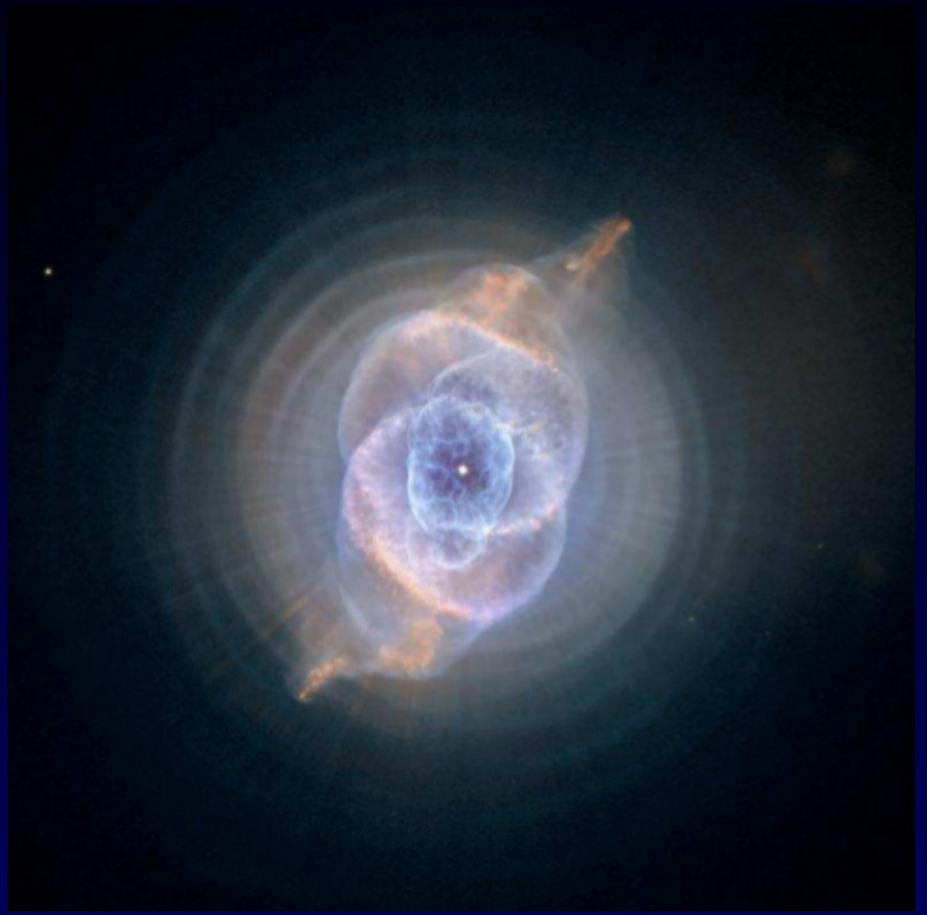
- Close binaries at period limit - analysis of collected observations, determination of evolutionary status, check the theories...
- Near contact binaries (NCBs) - analysis of NCBs, search for new NCBs (in clusters), compare evolutionary status and unveil the stage...
- Quadruple systems - important for checking models of stellar formation and evolution: unveiling new quadruple systems, study of period resonance...
- Chemically peculiar stars - measurements of photometric variability, derivation of rotational periods...





Theoretical research: **Study of stellar winds**

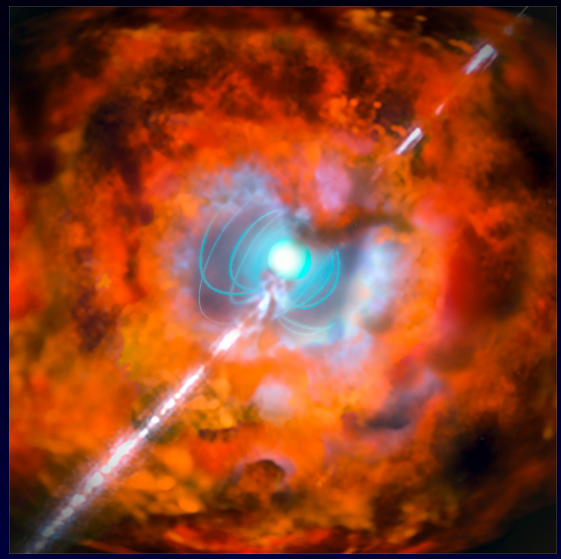
- Chemical composition of the early universe: hydrogen, helium, very small amounts of lithium, heavier elements are completely missing (C, N, O, Fe, ...)
- Where did the heavier elements come from?
- Heavier elements are formed during thermonuclear reactions inside stars
- How did the heavier elements get into the interstellar environment?
- There must be a way for stars to lose some of their mass

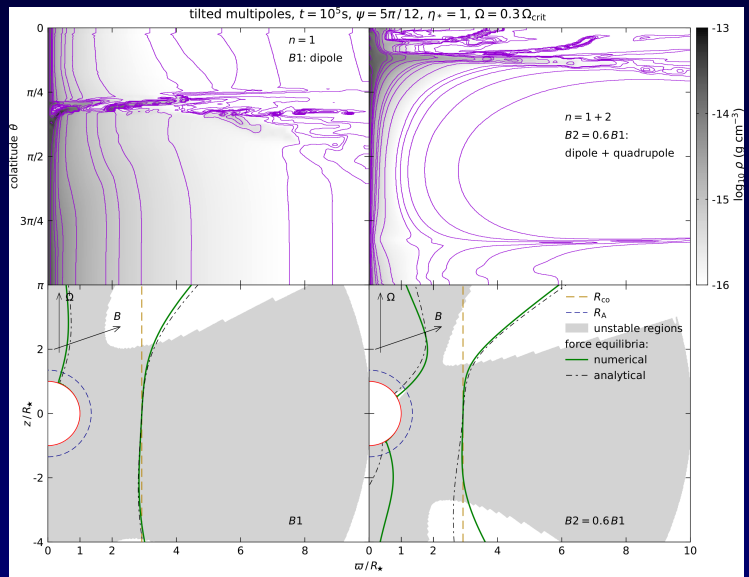


Planetary Nebula Cat's Eye - NGC 6543 (HST)

Study of stellar magnetospheres

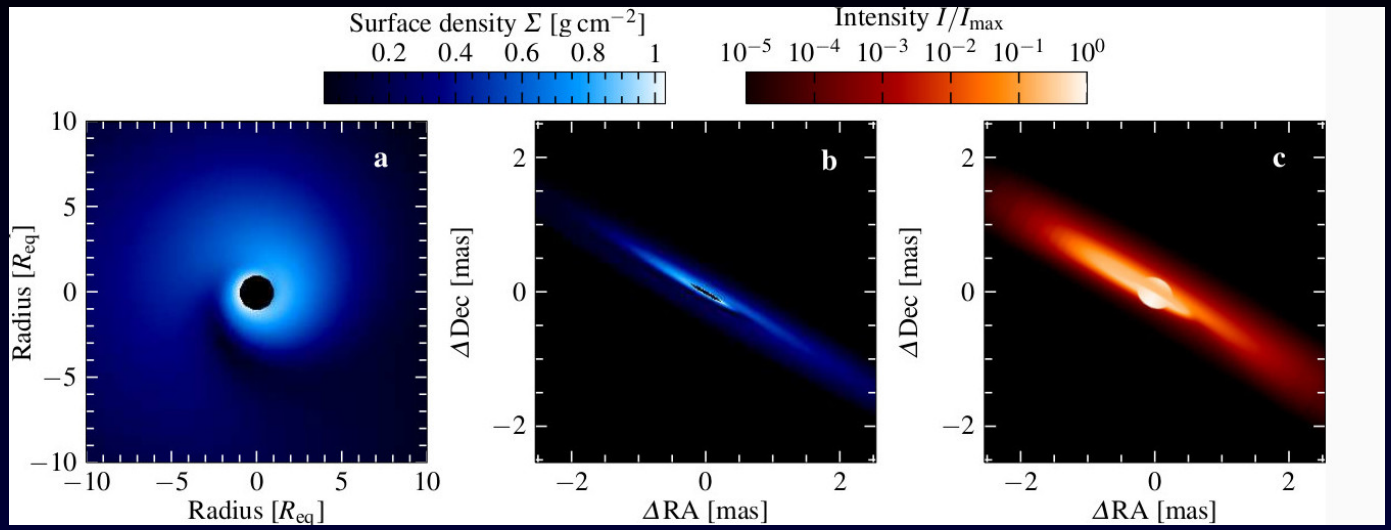
- Strong magnetic fields drastically influence the properties and rates of physical outflows from (stellar winds or eruptive events) from massive stars
- approximately 7% of Galactic OB stars harbor B-fields with strengths ranging from a few 100 G to some 10 kG
- In particular, magnetic OB stars quench a large amount of their mass flux and could become progenitors of heavy stellar-mass BHs, potentially linked with GW detections
- Other challenging issues (chemically peculiar stars, magnetars)





Combined tilted multipoles - dipole + quadrupole:

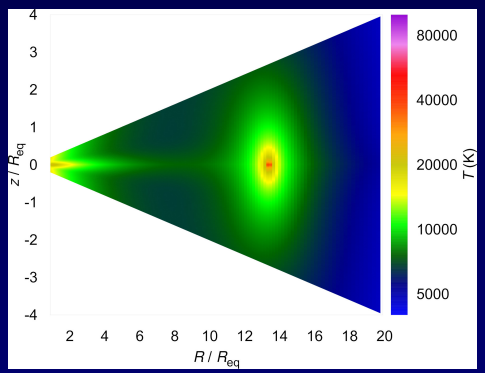
Study of aspherical CSE of hot stars



Models of a disk of the Be star ζ Tauri: Density perturbations when viewed "from above" and projected in the line-of-sight direction

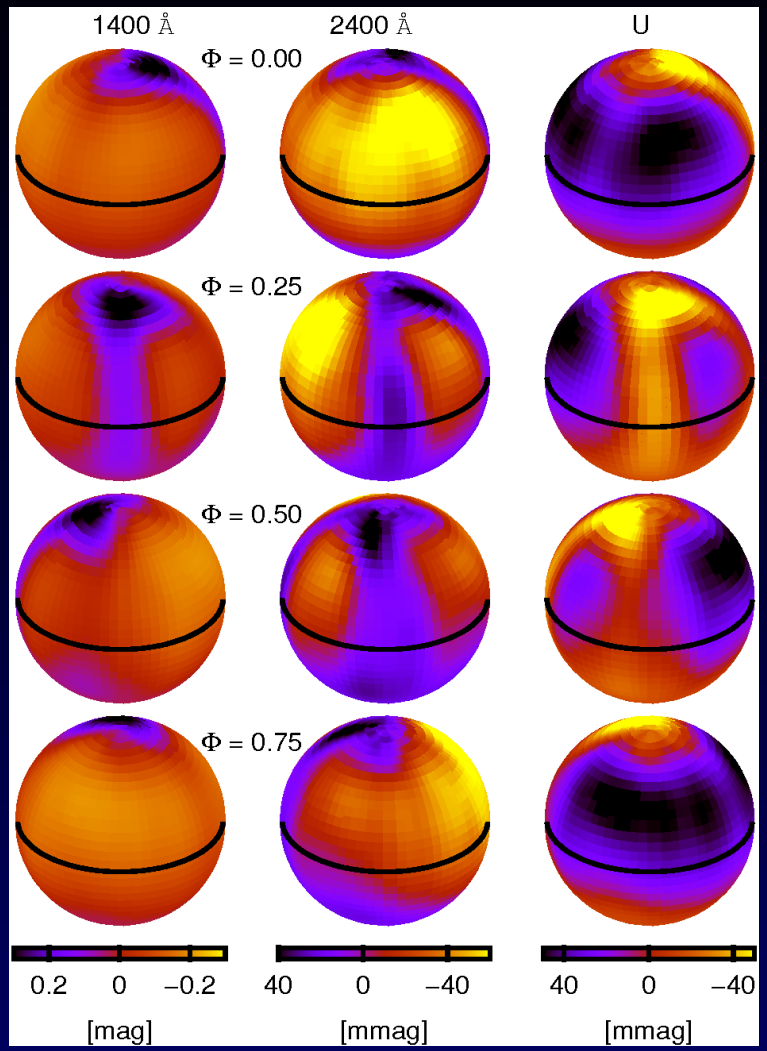
- Astrophysical objects of great importance for the evolution of stars, stellar systems, and the Universe in general

- We also study diverse set of objects associated with disks or with highly heterogenous aspherical CSE - B[e] stars, High-mass X-ray binaries, Be X-ray binaries, Pop III stars, etc.



Study of chemically peculiar (CP) stars

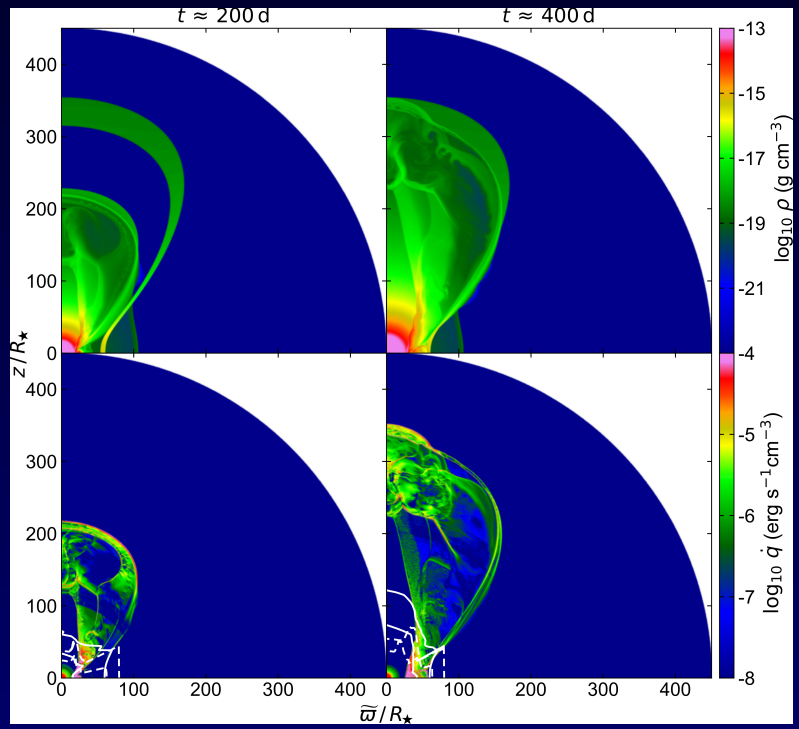
- Early spectral type stars with an unusual spectrum, caused by the abnormal distribution of heavier elements on the surface.
- Radiative diffusion, fossil magnetic fields, slow rotation.
- Observed photometric variability of the star during the rotation period.
- Spectrointerferometry, computer tomography $\rightarrow$ maps of surface distribution of the elements.
- One of the typical stars - φ Dra.



Distribution of Si and Fe on the surface of CP star φ Dra
(M. Prvák, J. Krtička, et al., 2015)

Study of SNe (cataclysmic processes)

- Supernovae of type II - gravitationally collapsing very massive stars, mostly red supergiants (also yellow, blue, and LBVs)
- Supernovae of type Ia - mostly thermonuclear explosion of C-O white dwarf in a binary system
- The shock produced by a supernova may probe the mass loss history of the progenitor system back to ages of more than 10 000 years before the explosion
- Supernovae (SNe) chemically enrich their host galaxies and may trigger formation of future generation of stars



Thank you, and:

enjoy the CPB meeting 2022 in Brno!