"Reading between the lines'' magnetospheric accretion, winds, and the inner disk

Sicilia-Aguilar, A.; Campbell-White, J.; Bouvier, J.; Roccatagliata, V.; Matsumura, S.; Fang, M.; ... ; Kospal, A.

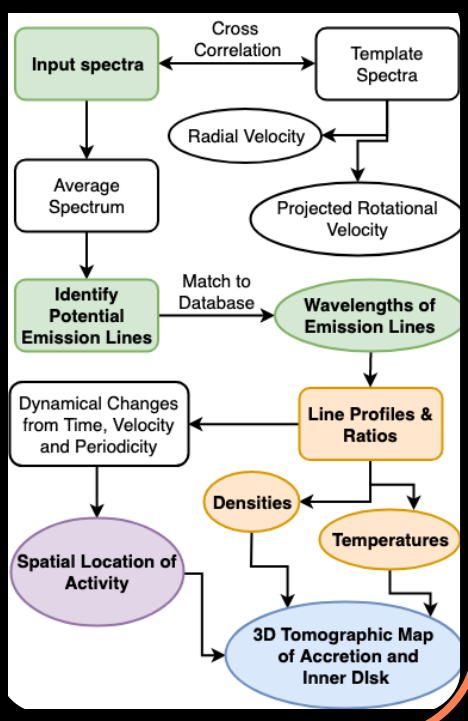
"Reading between the lines": Magnetospheric accretion, winds, and the inner disk

Aurora Sicilia-Aguilar[1], Justyn Campbell-White[1], Jerome Bouvier[2], Veronica Roccatagliata[3], Soko Matsumura[1], Min Fang[4], Carlo Manara[5], Jos de Boer[6], Ágnes Kóspál[7]

1: University of Dundee 2: IPAG Grenoble 3: University of Pisa 4: Purple Mountain Observatory 5: ESO 6: Leiden Observatory 7: Konkoly Observatory

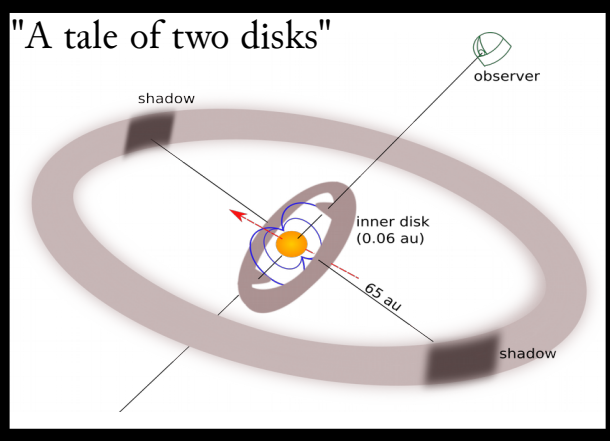
STAR-MELT: What can you learn "reading between the lines" ?

Time- and velocity-resolved data using emission (and absorption) lines in young stars reveal their winds, accretion-related structures, spots, and innermost disk at few-stellar-radii to sub-au scales. Optical spectra have a large number of metallic species with various excitation potentials, useful to trace the temperature, density, and velocity of hot and tiny structures. Time-resolved data covering several rotational and disk orbital periods reveal a very detailed view of the structure of accretion columns and spots and information on the properties and location of stellar/disk winds in young stars. STAR-MELT [Campbell-White+2021 to be subm] is optimized for line extraction and fitting, and will be made public as a Python package soon.

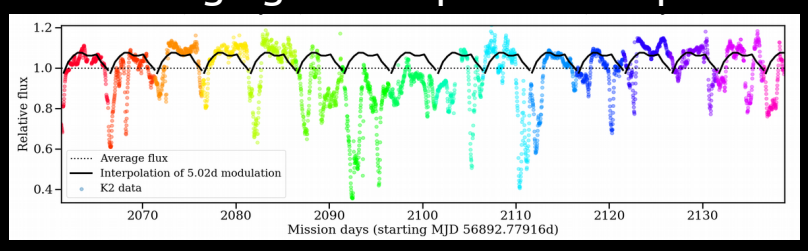


STAR-MELT is funded by STFC grant ST/S000399/1

J1604: Disk evolution at 0.06-4 au

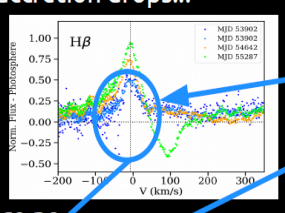


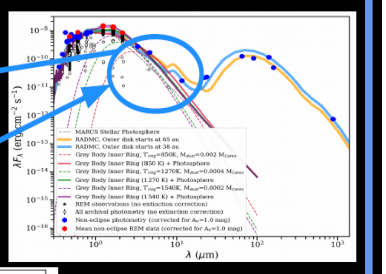
Accretion fills and drains the innermost highly inclined disk every 10-20 days, changing the shape of the dips.



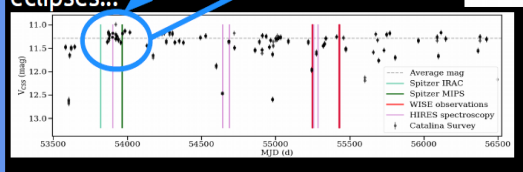
Moreover:

When accretion drops...





... there are no eclipses...

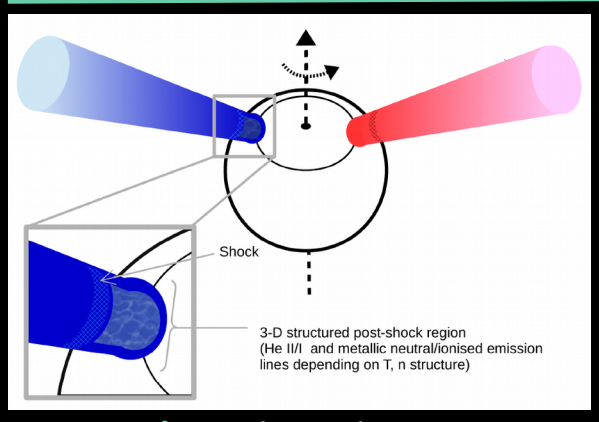


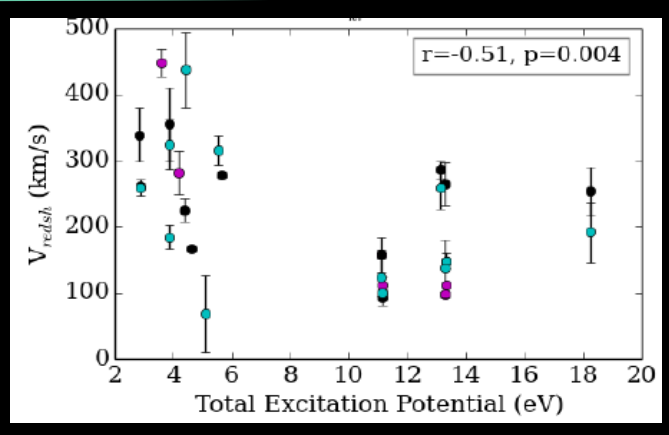
... and no inner disk!

Major changes in the disk occur every ~2-4yrs.

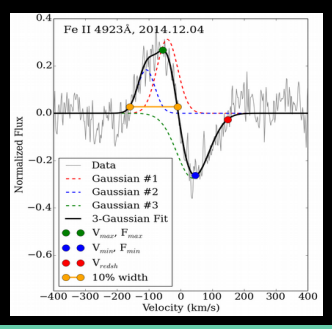
The inner disk appears and disappears on few-year timescales, betraying "something" at few au in the disk that affects mass transport [SA+2020a]

Outbursting stars: EX Lupi and ASASSN13db



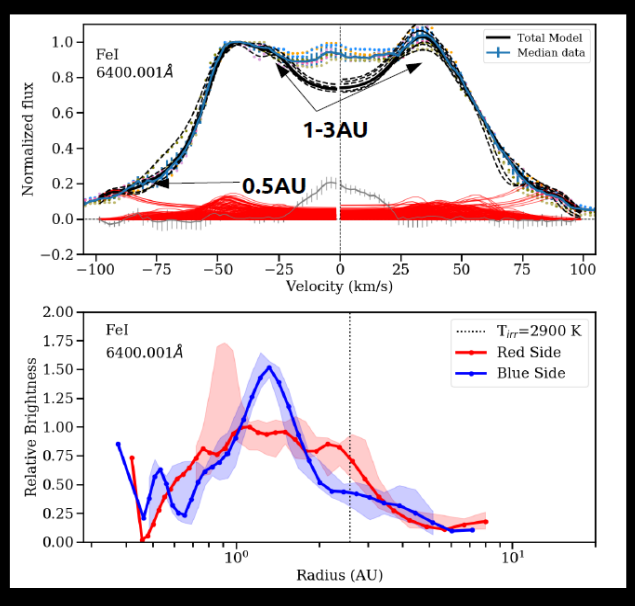


EX Lupi: High- vs low-energy lines trace very stable accretion columns with a temperature and density stratification (and even trailing/distribution over the stellar surface) [SA+2015]

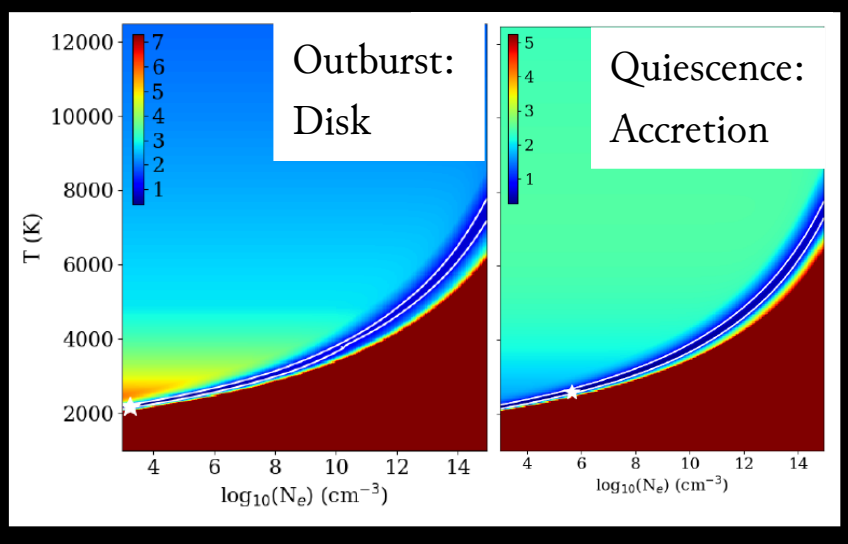


13db: Energetics of lines reveals hot spot hovering over surface of M5 star [SA+2017]

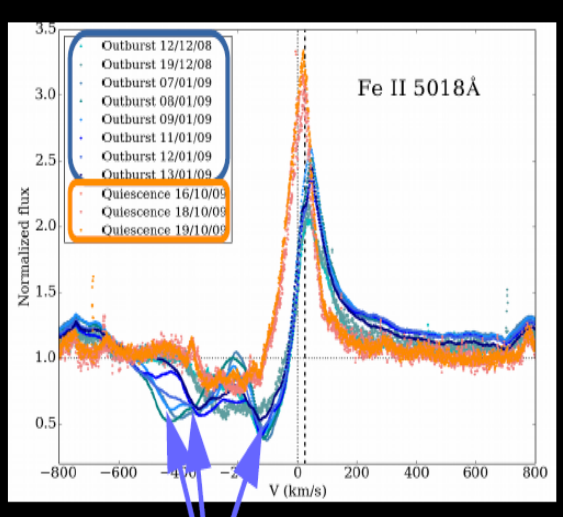
ZCMa NW: Accretion, inner disk, and non-axisymmetric winds in an intermediate-mass star



Peering through the inner (0.5-3 au) disk at various heights via weak/strong Fe I lines: midplane vs surface asymmetries.



Lines with the same profiles can be used to track temperatures and densities in outburst and quiescence



Multiple variable, non-axisymmetric winds from star and disk [Sicilia-Aguilar et al. 2020b]

References

Campbell-White et al. subm soon!
See JCW poster & haiku

SA et al. 2015, A&A 580, 82
SA et al. 2017, A&A 607, 127
SA et al. 2020a, A&A 633, 37
SA et al. 2020b, A&A 643, 29

Your stars are no longer young? You have lines but no stars? No problem! If lines are there, STAR-MELT can find them and read between them! *Please contact ASA & JCW for details.*