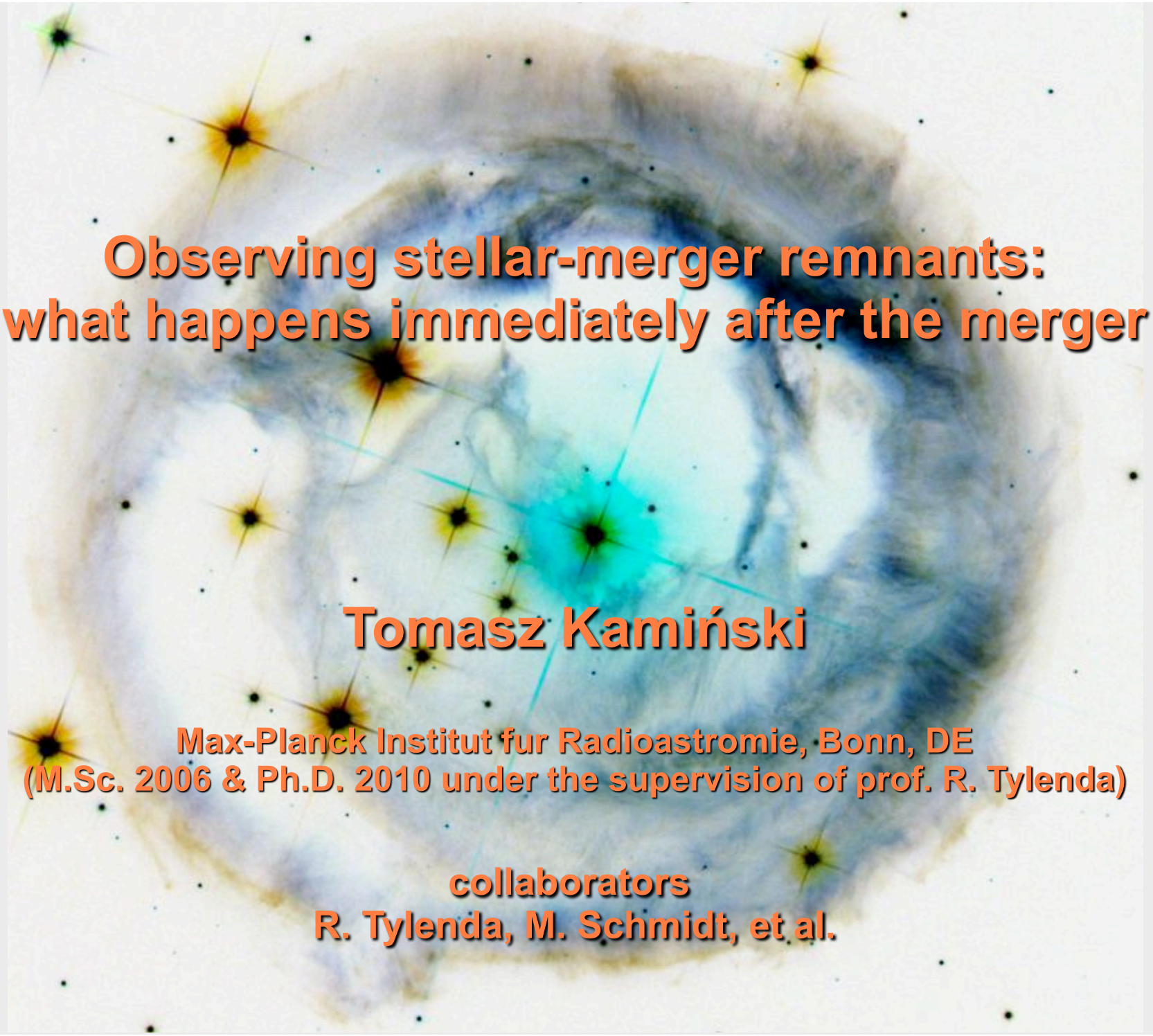


Observing stellar-merger remnants: what happens immediately after the merger

Tomasz Kamiński

Max-Planck Institut fur Radioastromie, Bonn, DE
(M.Sc. 2006 & Ph.D. 2010 under the supervision of prof. R. Tylenda)

collaborators
R. Tylenda, M. Schmidt, et al.

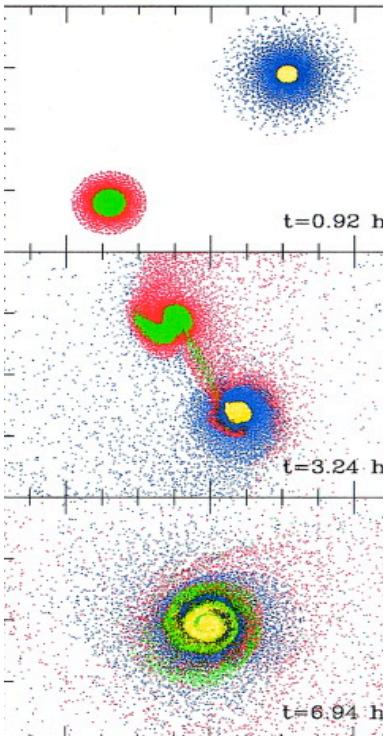
Red novae (tylendars) — stellar merger phenomena

- intermediate spectral types in outburst
- light curve with multiple peaks
- matter ejected at velocities of a few hundred km/s
- quick cooling after the outburst (no coronal phase)
- cool remnant (M-type spectrum) with rich circumstellar environment
    - dusty
    - low-excitation gas

Why we observe the remnants of red novae:

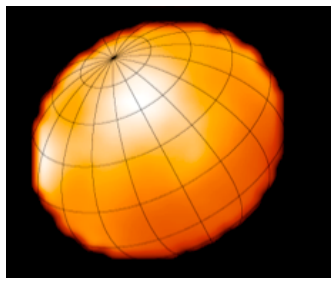
➢investigate the product of the merger
and verify predictions about the remnant

- fast rotators
- disk/torus formation
- mass loss (outflow, wind, ejecta)
- strong magnetic fields (magnetic braking?)
- elemental abundance patterns



➢constrain better the nature of the progenitors

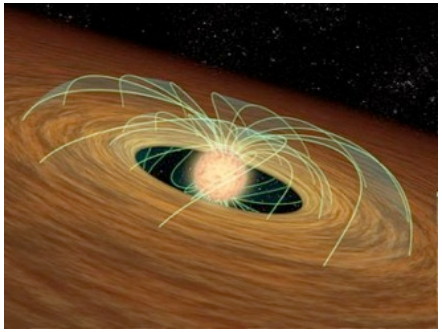
- look for material of the common envelope?
- mass-loss history
- interstellar environment

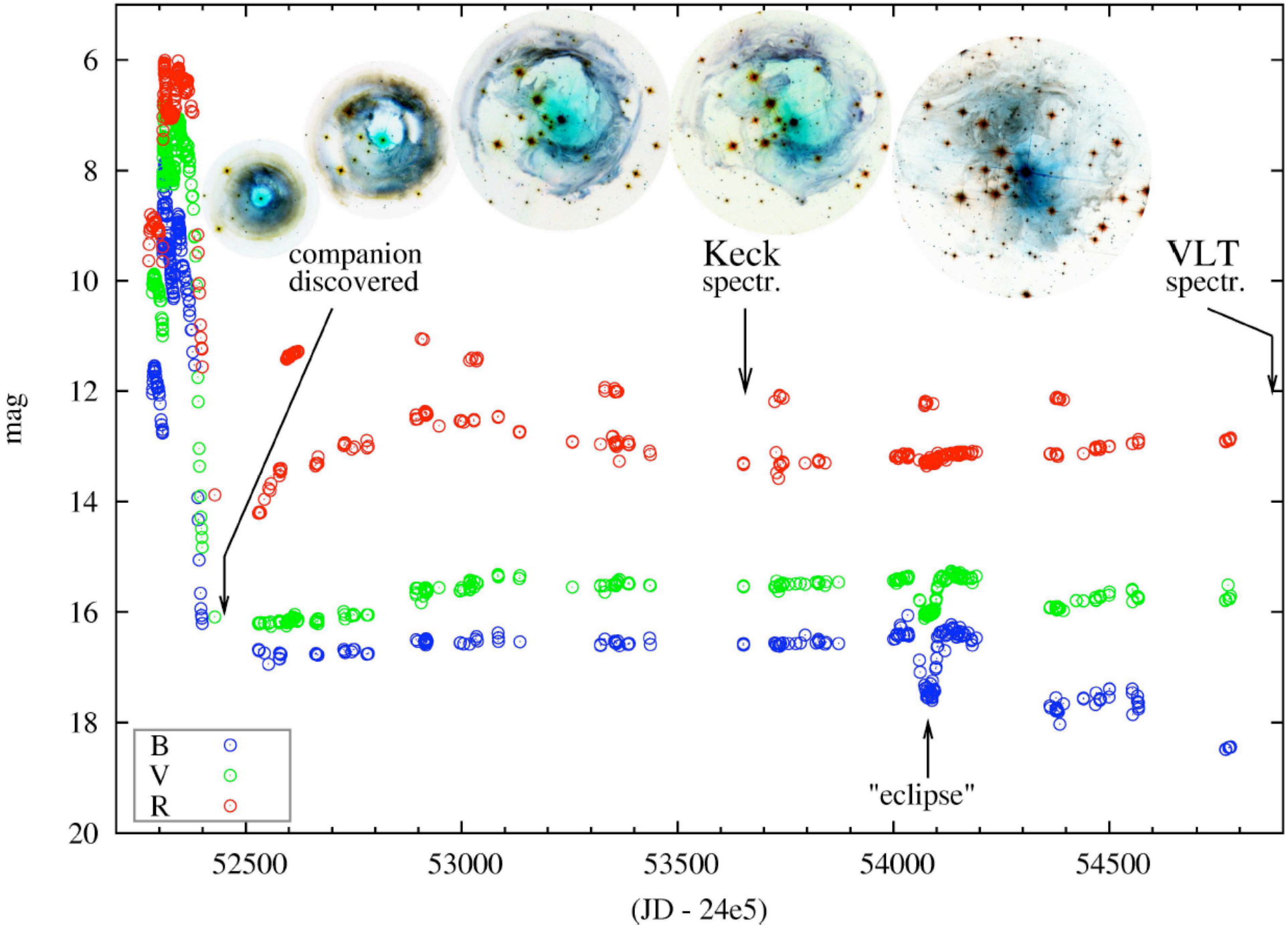


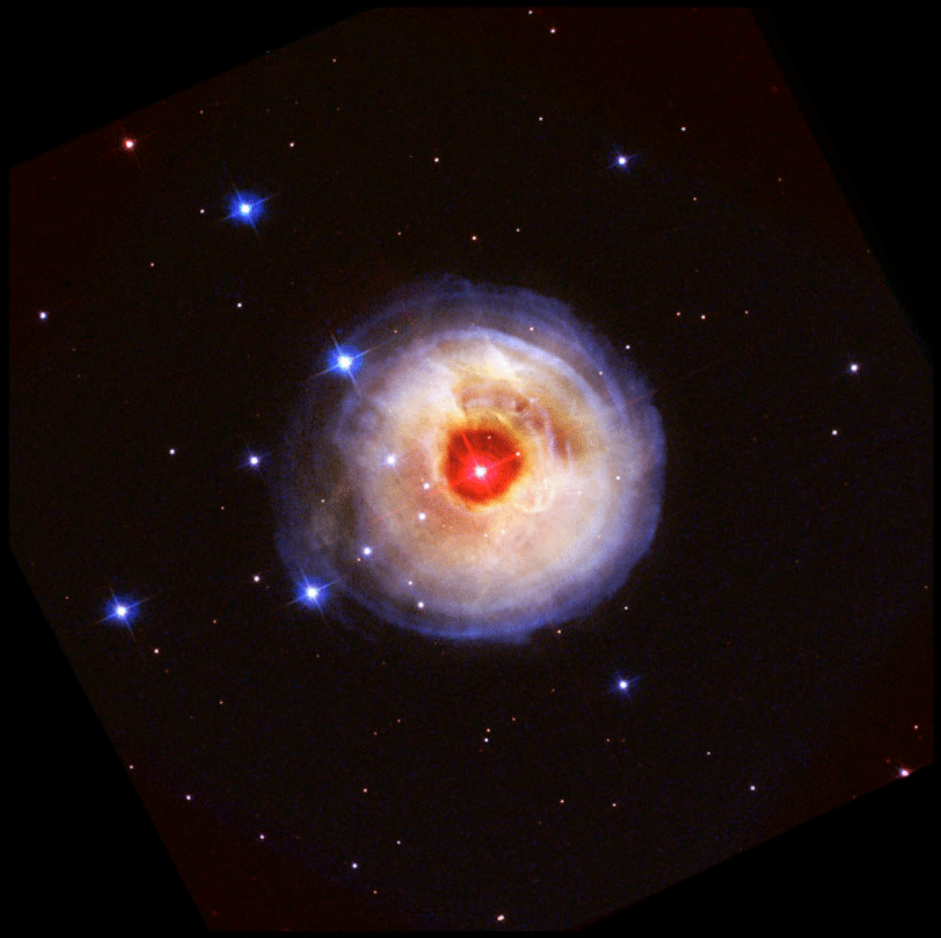
➢only observations can show us
what really happens just after a merger

➢I will focus on only 3 object

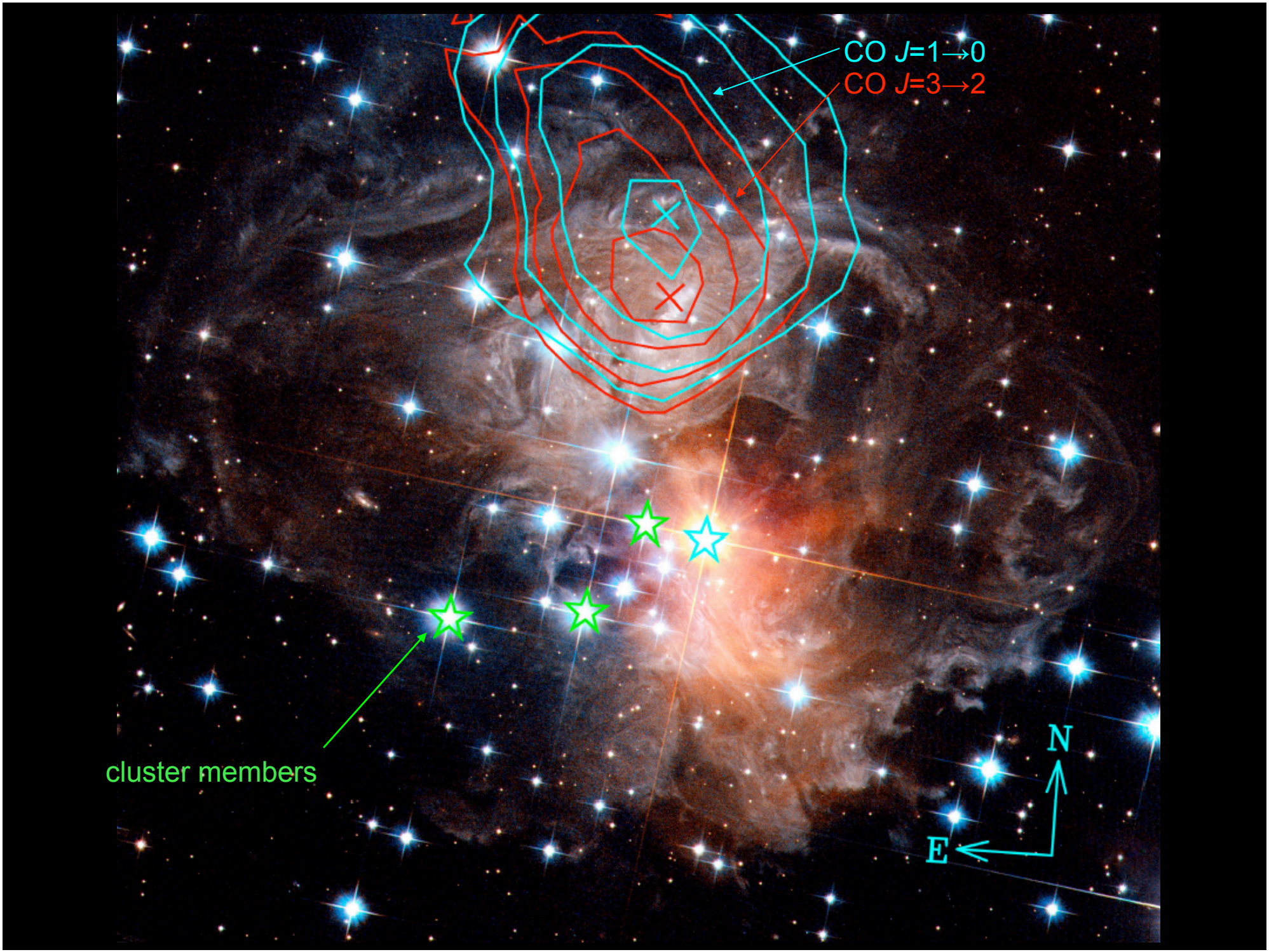
- V838 Mon
- V4332 Sgr
- V1309 Sco

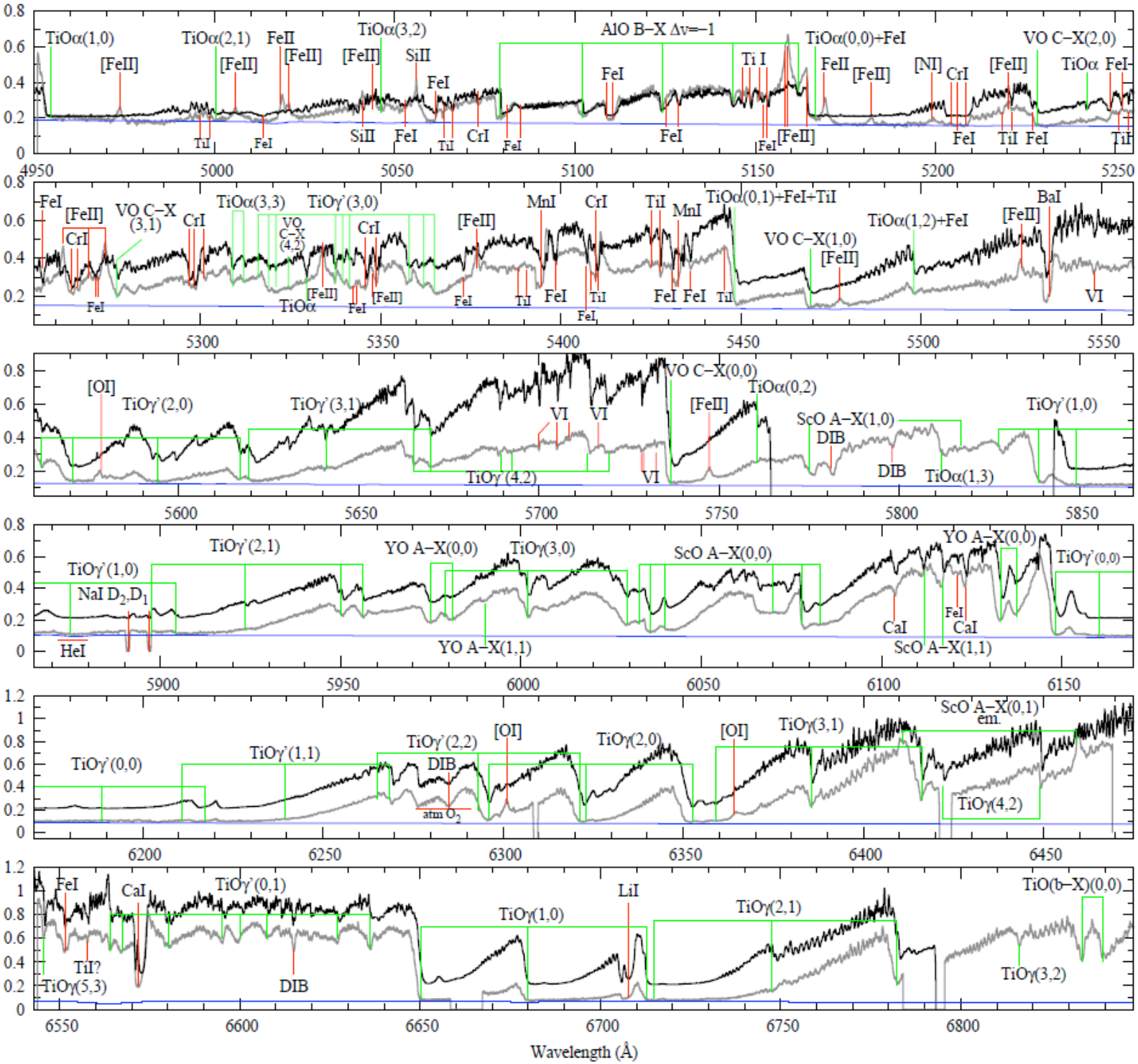



companion
discovered
Keck
spectr.
VLT
spectr.
"eclipse"
B
V
R
mag
(JD - 24e5)
6
8
10
12
14
16
18
20
52500
53000
53500
54000
54500



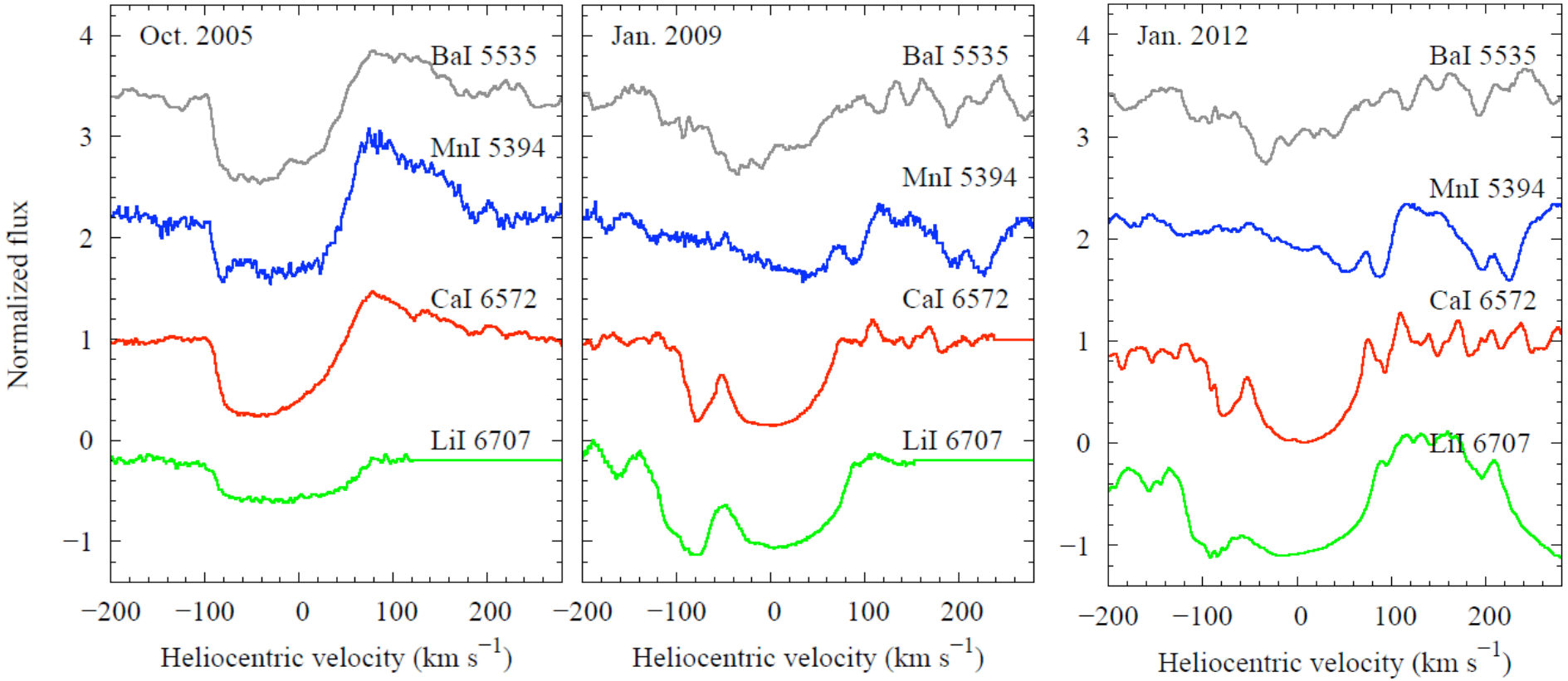
V838 Mon's
light echo
HST/ACS
Bond et al.


CO J=1→0
CO J=3→2
cluster members
N
E



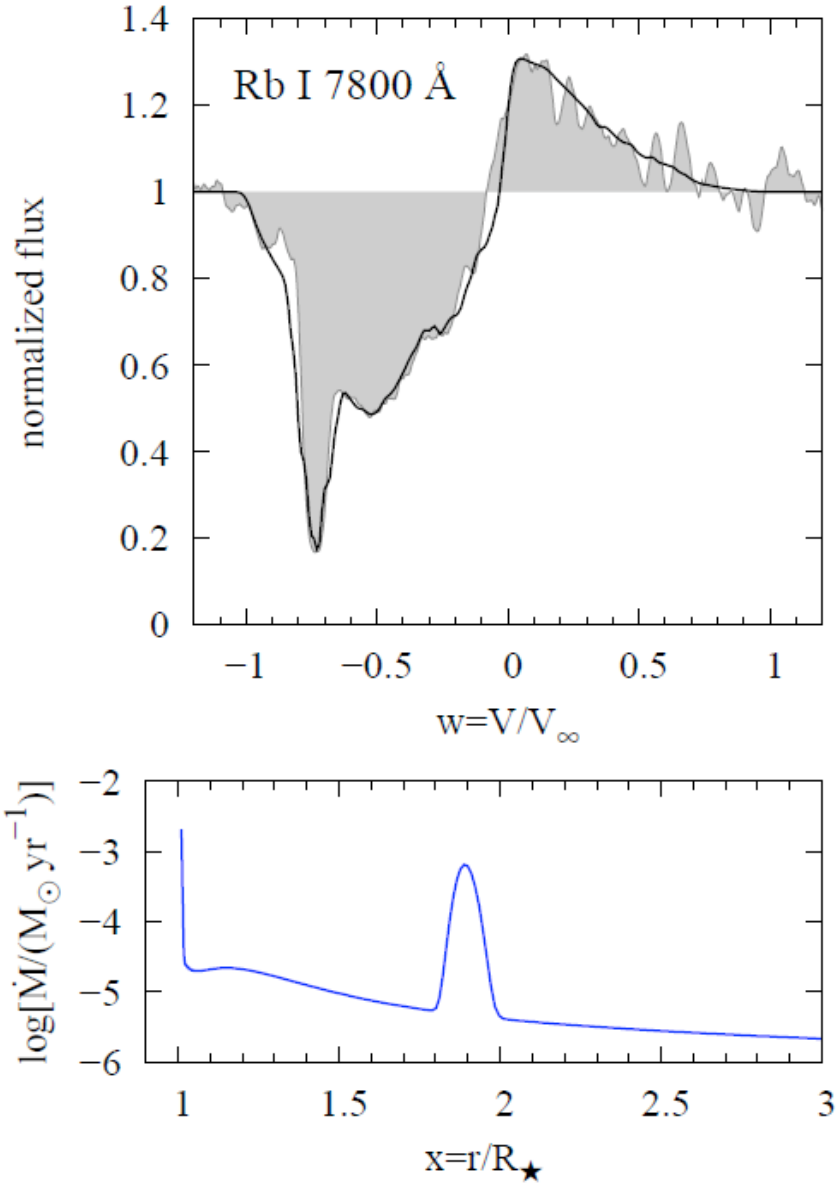
V838 Mon
2005 vs 2009

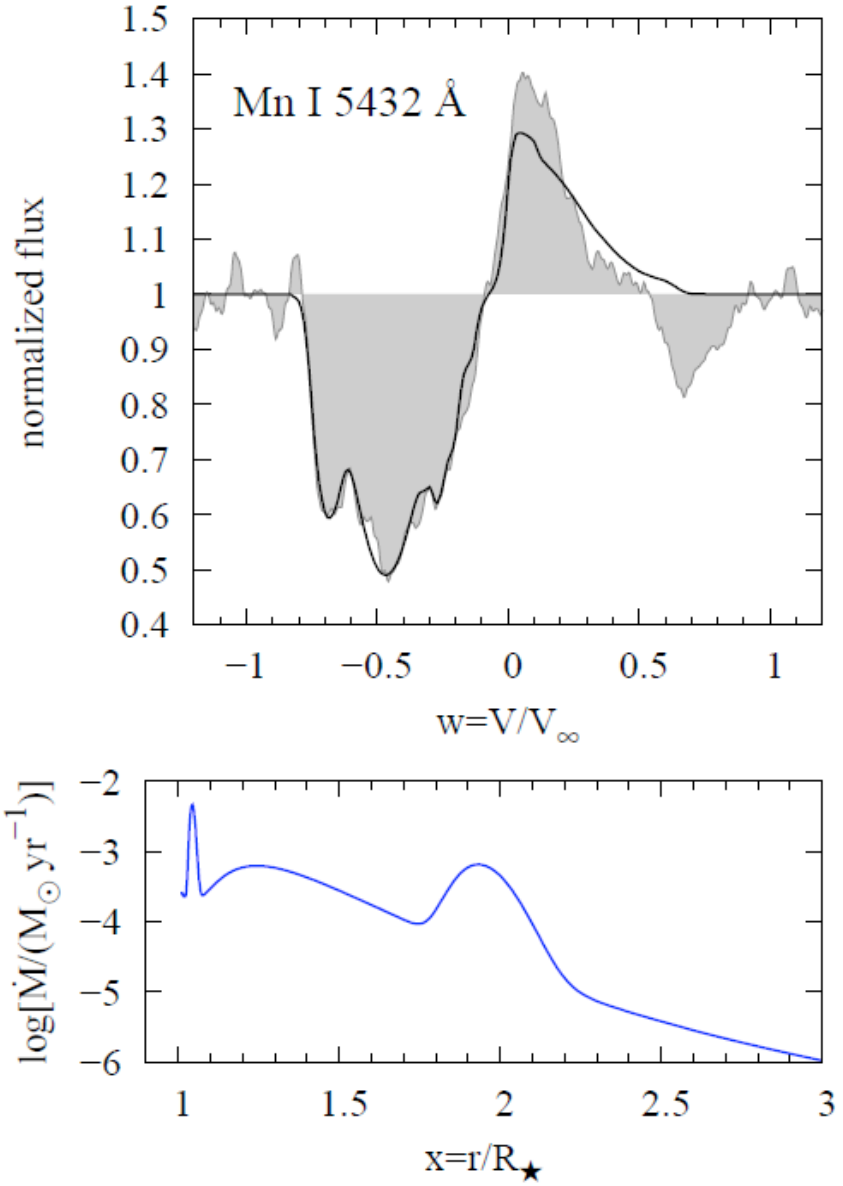
Profile changes in V838 Mon - variable wind or ejecta?



Kamiński et al. 2009, 2010

The unstable (?) wind of V838 Mon





The birth of SiO masers in V838 Mon

Detection of SiO Maser Emission in V838 Mon

Shuji DEGUCHI
Nobeyama Radio Observatory, National Astronomical Observatory, and Department of Astronomical Science, The Graduate University for Advanced Studies, Minamimaki, Minamisaku, Nagano 384-1305
and
Noriyuki MATSUNAGA and Hinako FUKUSHI
Institute of Astronomy, School of Science, The University of Tokyo, 2-21-1 Osawa, Mitaka, Tokyo 181-0015

(Received 2005 May 11; accepted 2005 July 2)

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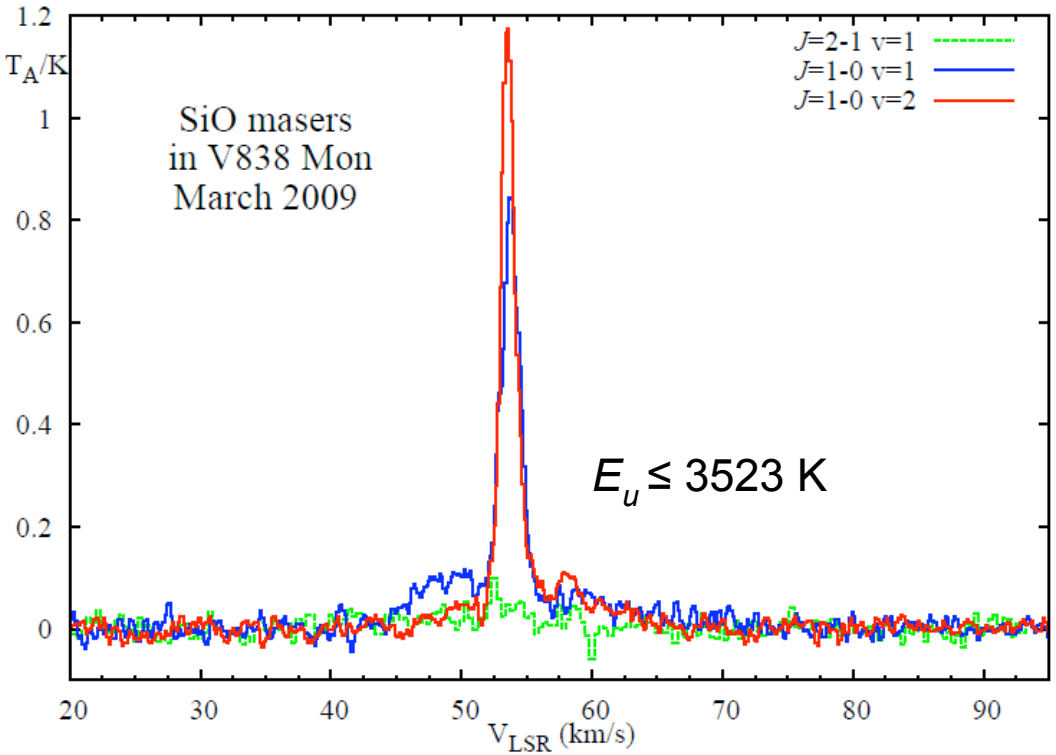
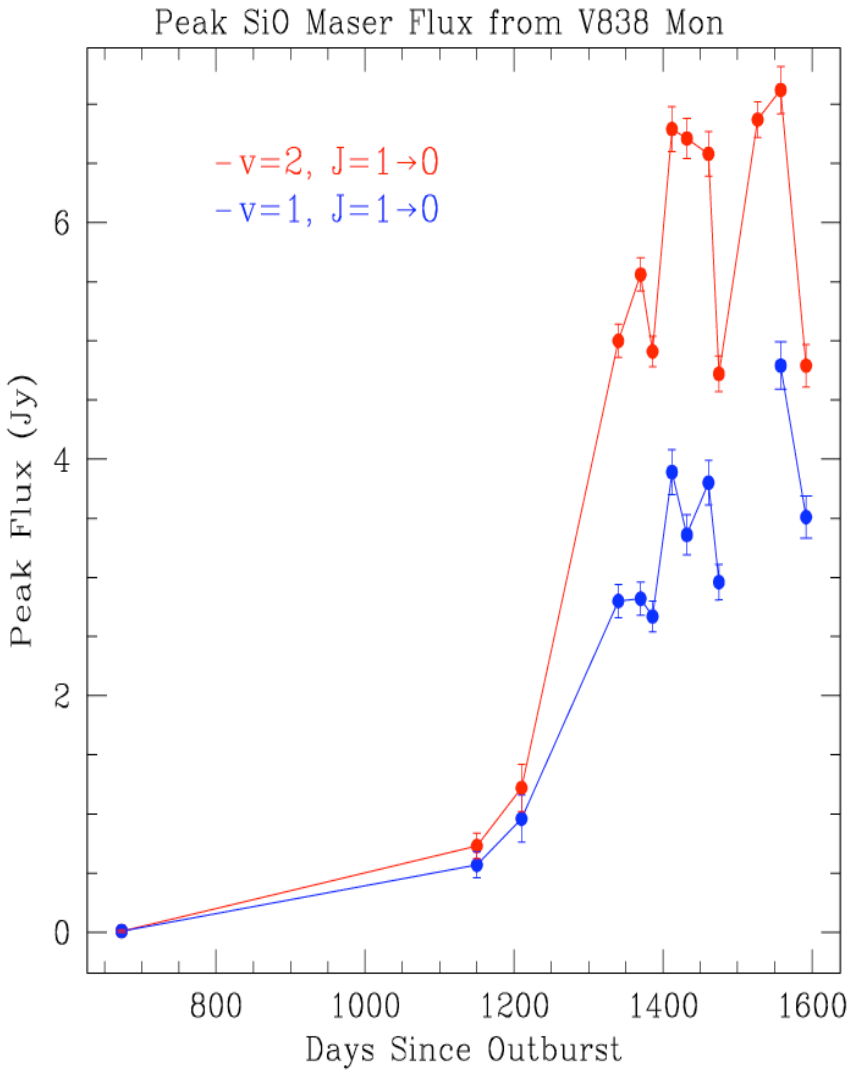
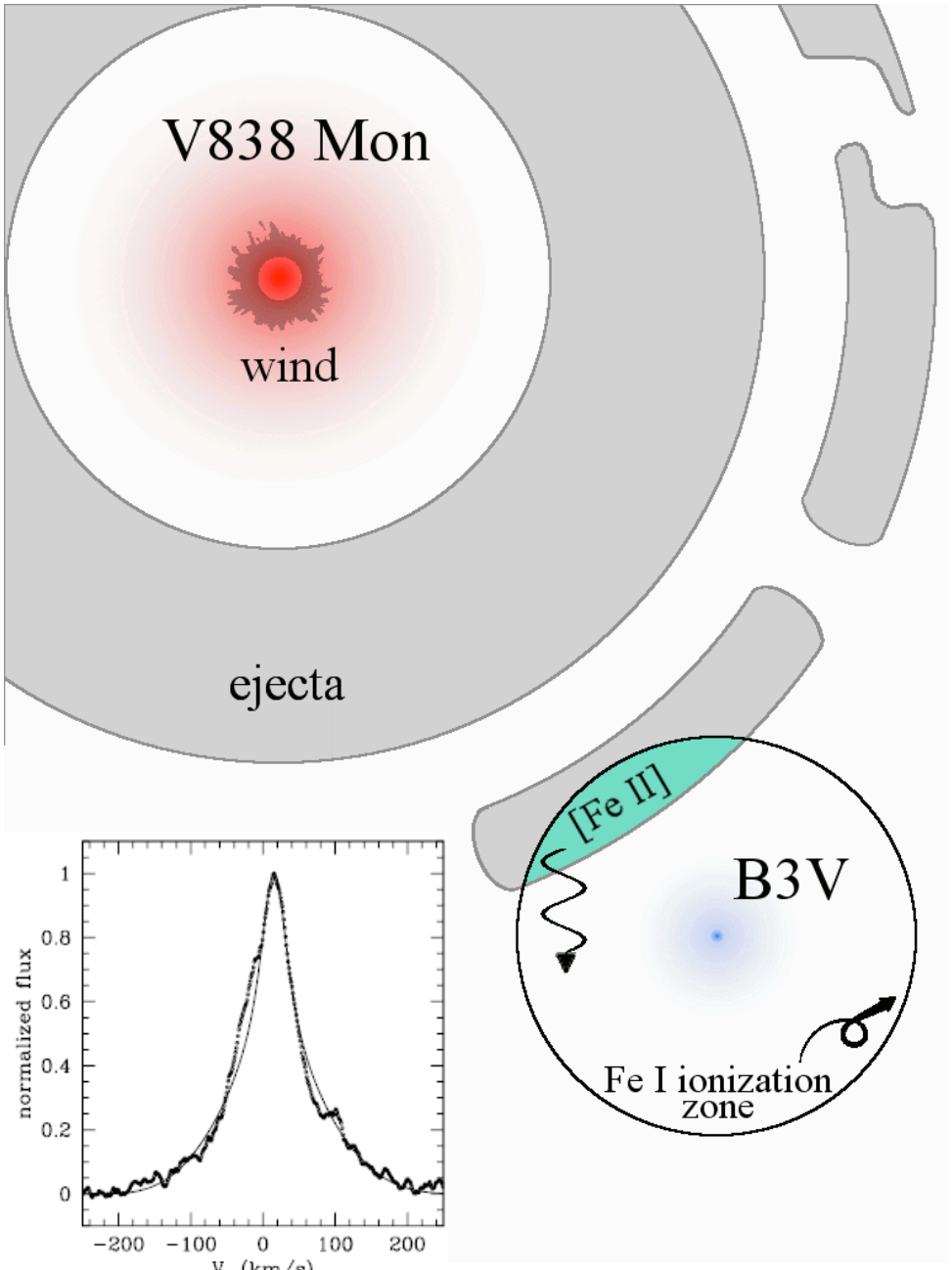
for reporting and commenting on new astronomical observations

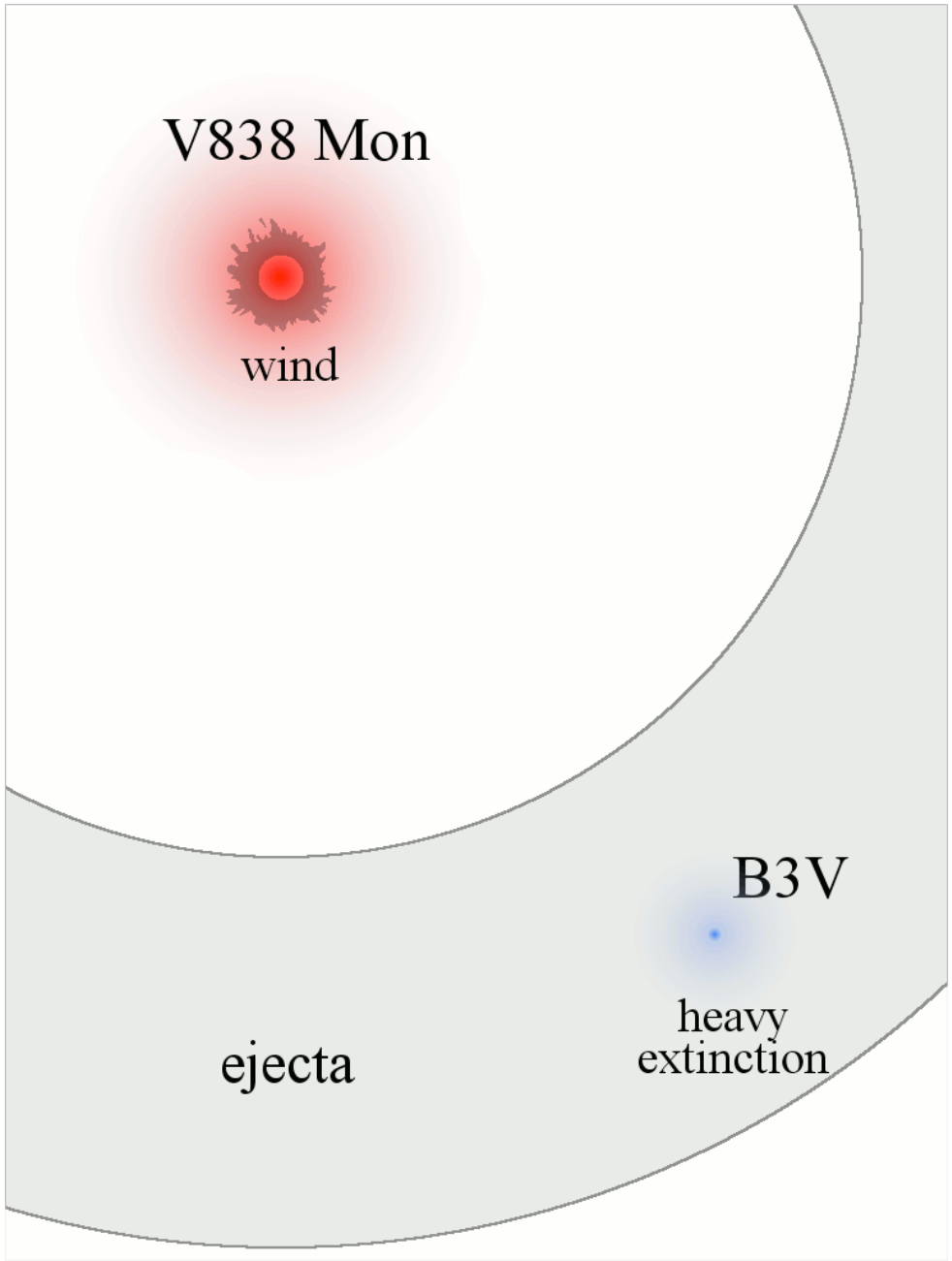
Detection of the SiO J=2-1 v=1 maser emission at 86.2 GHz in V838 Mon, an unusual nova-like variable





Claussen et al. 2006

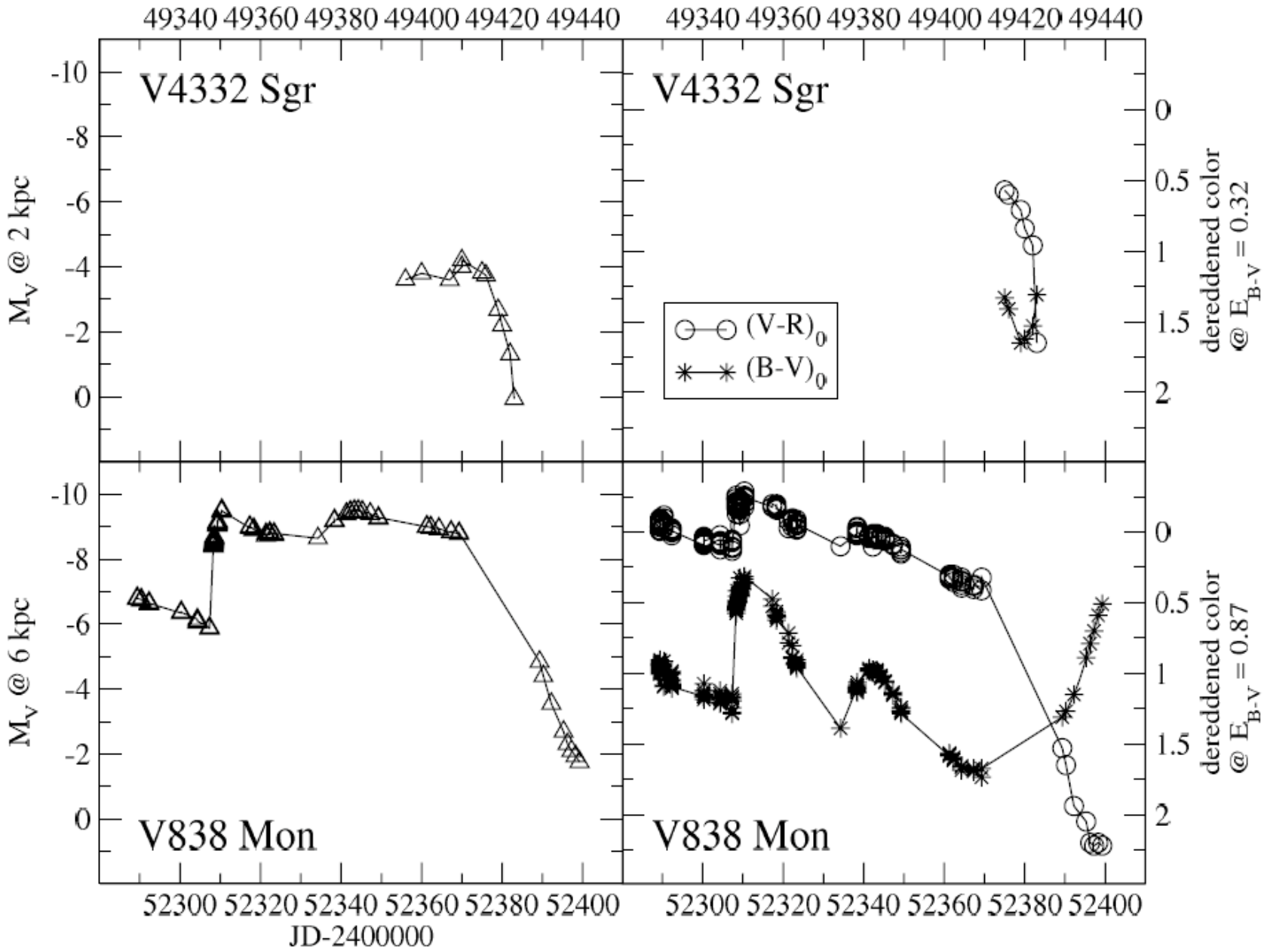




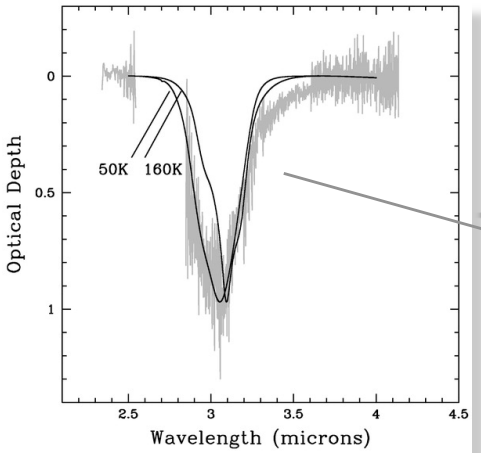
V838 Mon in ~2005 → *and after ~2006 (last observations 2012)*


V4332 Sgr

Similarity to V838 Mon



SED of V4332 Sgr



BB 200 K+950 K

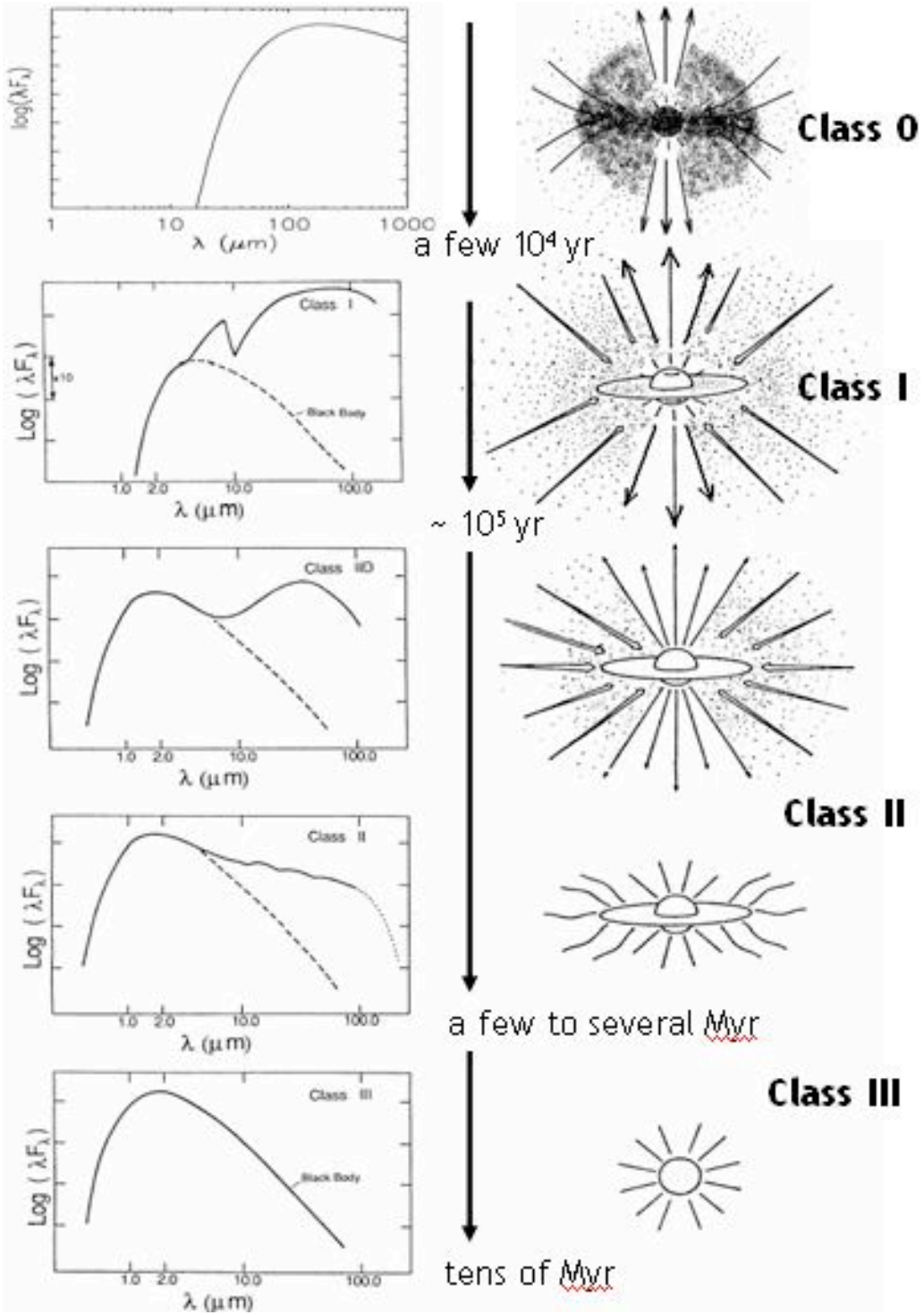
MARCS 3200
photospheric
contribution

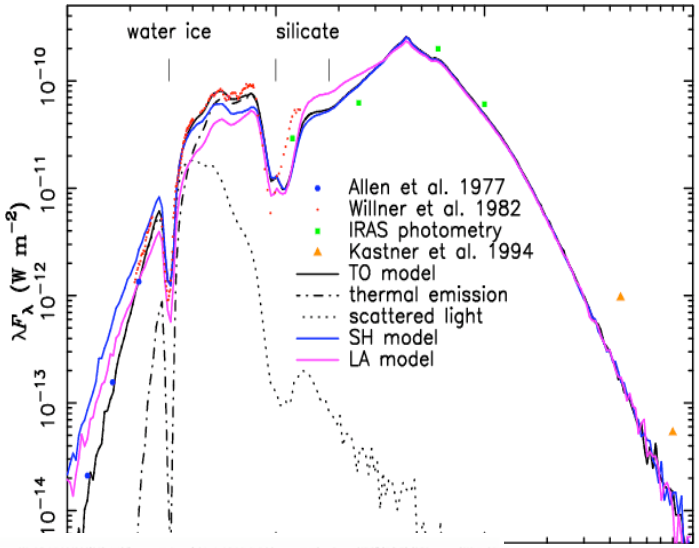
$\log(\nu F_\nu\ (\mathrm{erg\ cm^{-2}\ s^{-1}}))$

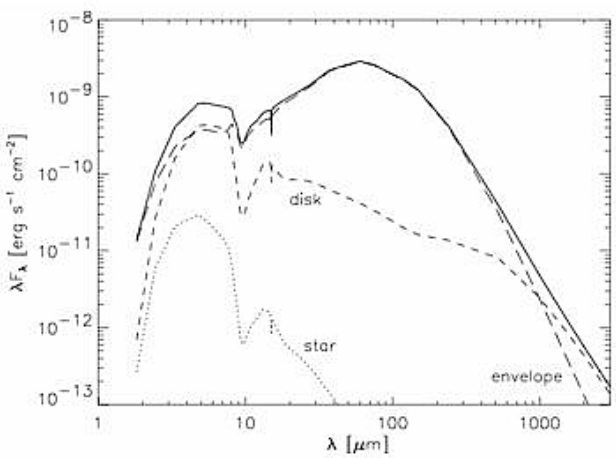
-11
-12
-13
-14

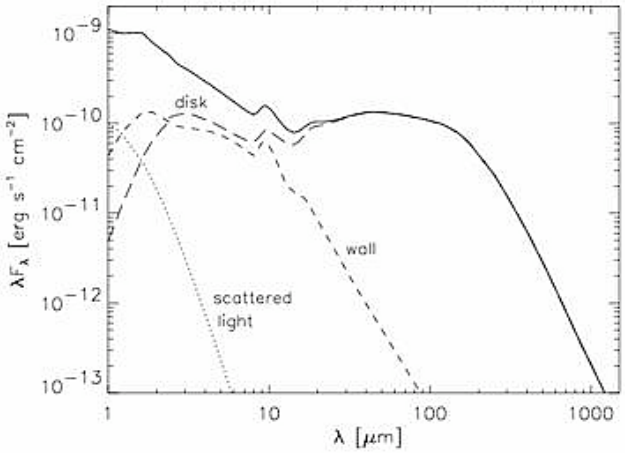
1
10
100

Gomez's Hamburger

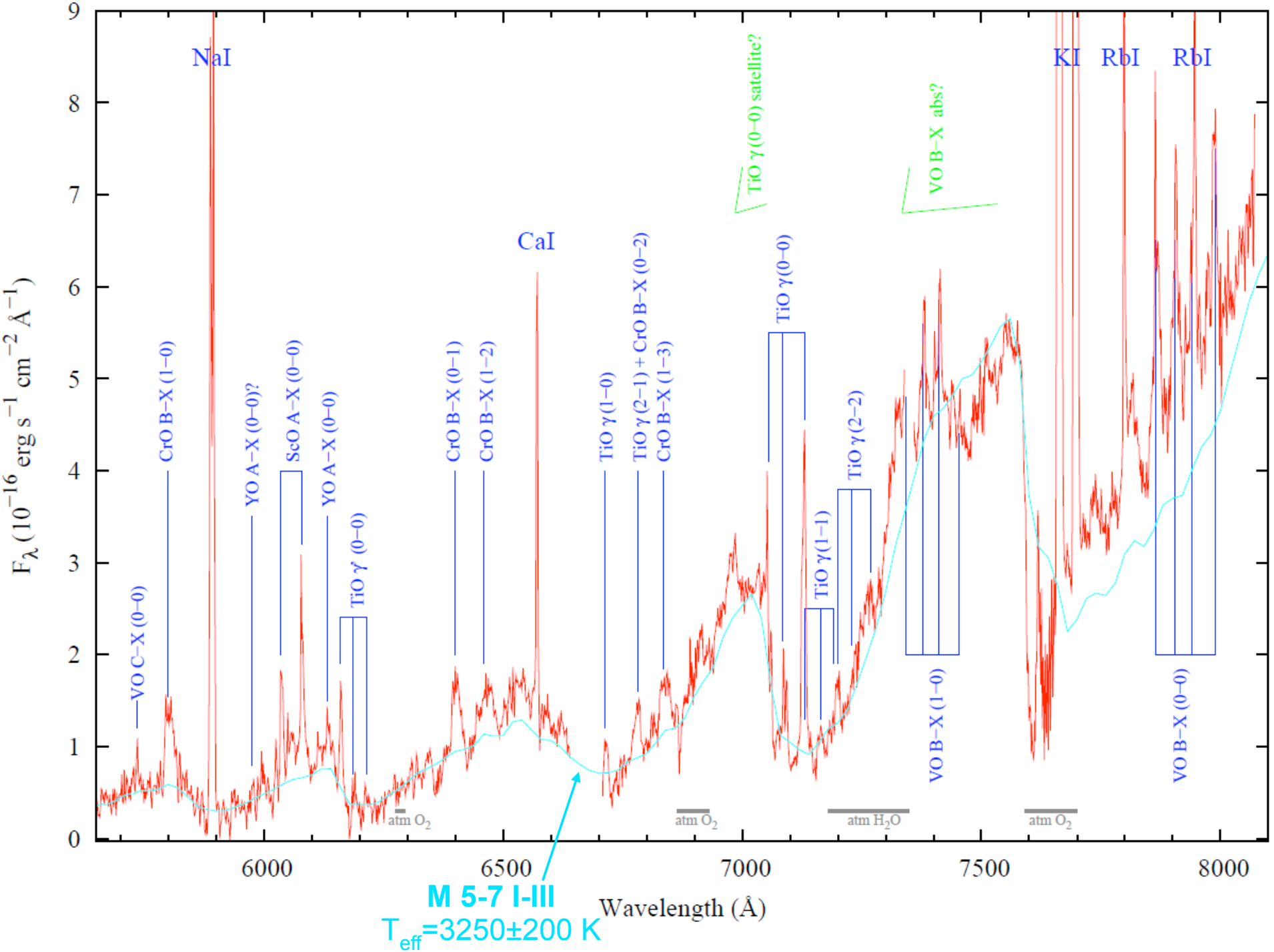

log(λF_λ)
1
10
100
1000
λ (μm)
Class 0
a few 10⁴ yr
Class I
Log (λF_λ)
Black Body
~ 10⁵ yr
Class II
Class III
a few to several Myr
tens of Myr


water ice
silicate
Allen et al. 1977
Willner et al. 1982
IRAS photometry
Kastner et al. 1994
TO model
thermal emission
scattered light
SH model
LA model
λF_λ (W m⁻²)

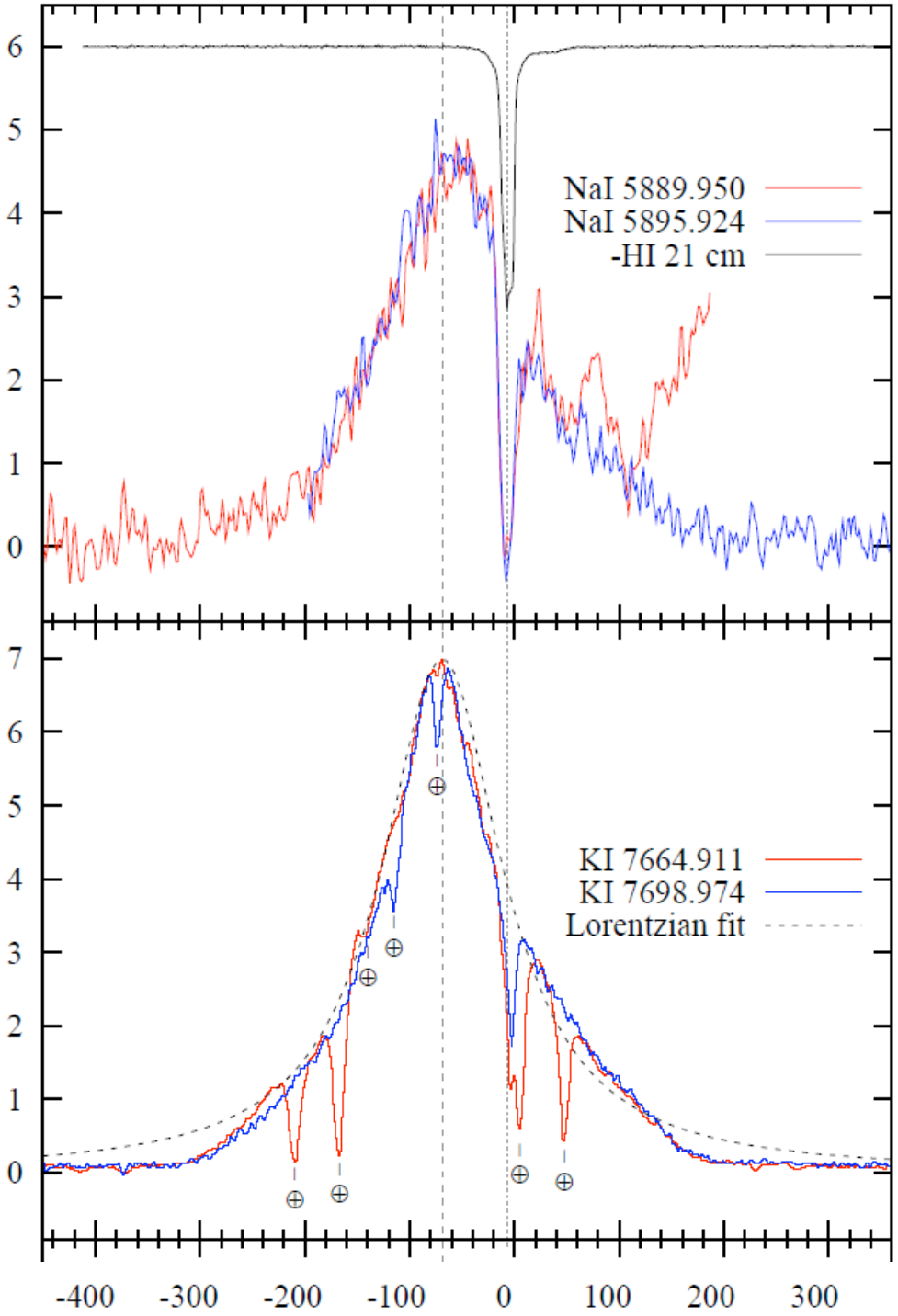

disk
star
envelope
λF_λ [erg s⁻¹ cm⁻²]
λ [μm]

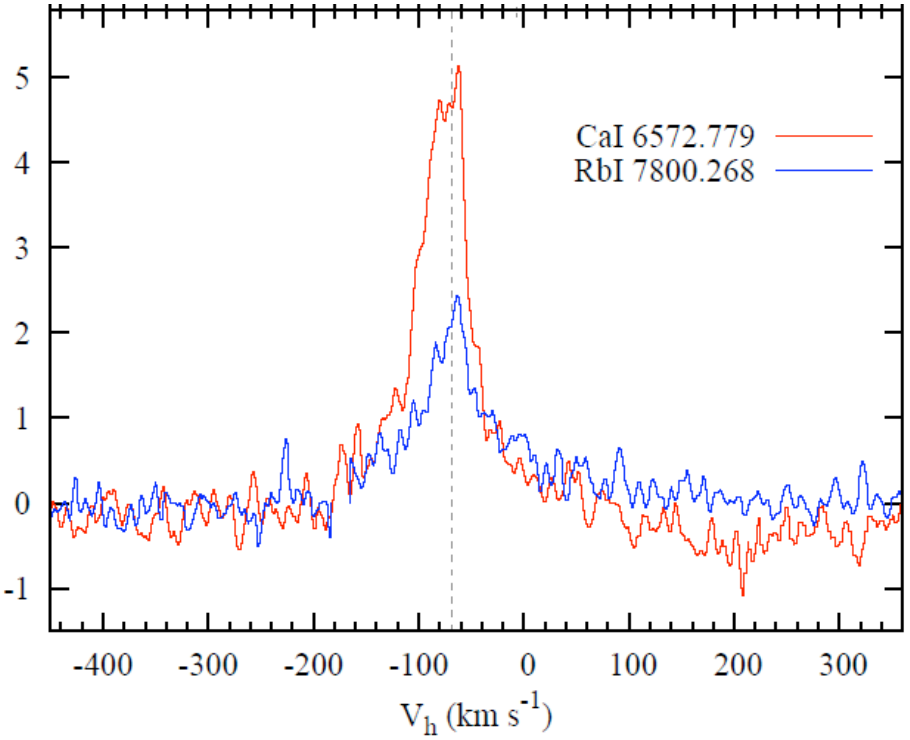

disk
wall
scattered light
λF_λ [erg s⁻¹ cm⁻²]
λ [μm]

V4332 Sgr, 2009



Atomic lines





Origin of the emission features II

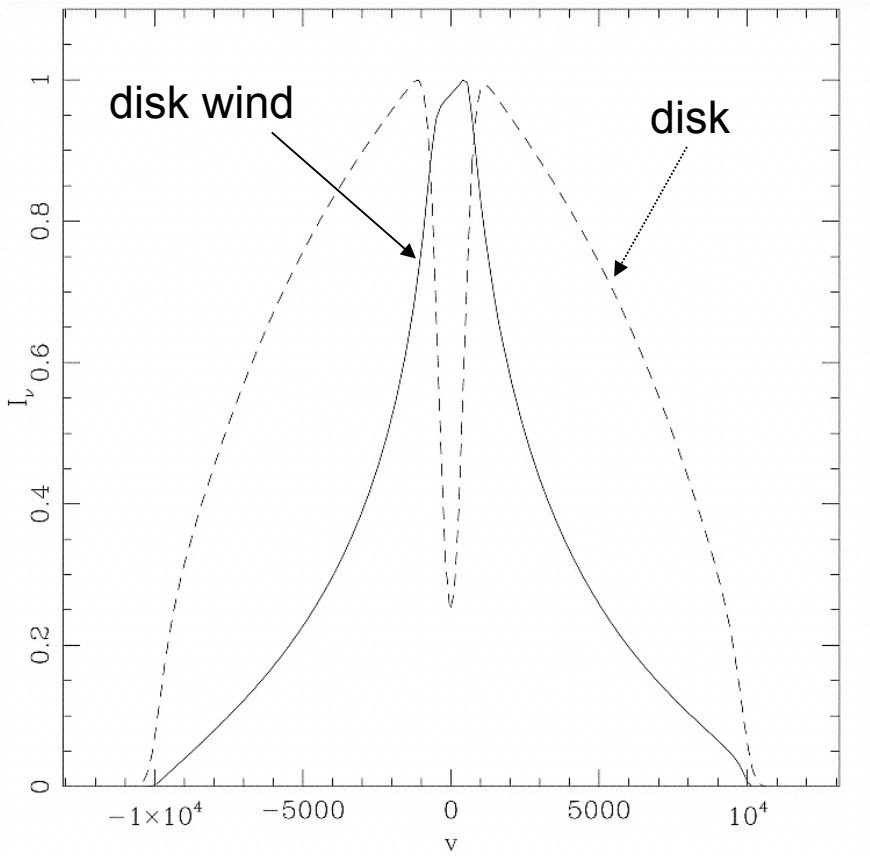
- if the lines arise in a disk seen at a high inclination they are expected to be double-peaked

- models if the disk at *i*~90˚ has a thick wind (disk-wind), single-peaked profiles may appear, see e.g. models of Murray & Chiang (1996,1997)

  - model seems to work fine for KI and NaI lines but not for the RbI and CaI lines which are optically thin

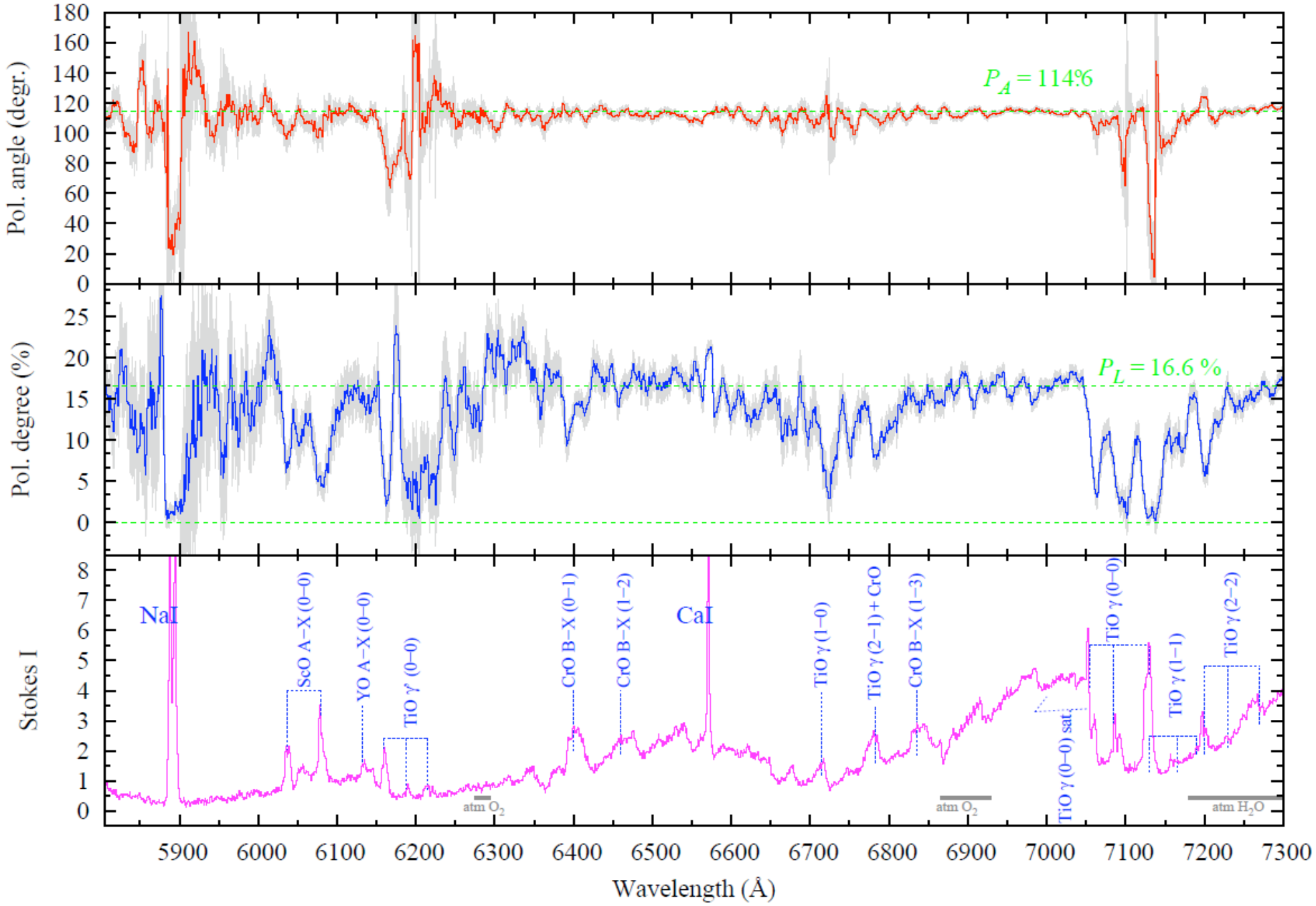
  - the lines are too broad (FWZI=230 km/s) to be explained by Keplerian motion (for $1M_{\odot}$ star with $50R_{\odot}$ the Keplerian velocity at the surface is 60 km/s)

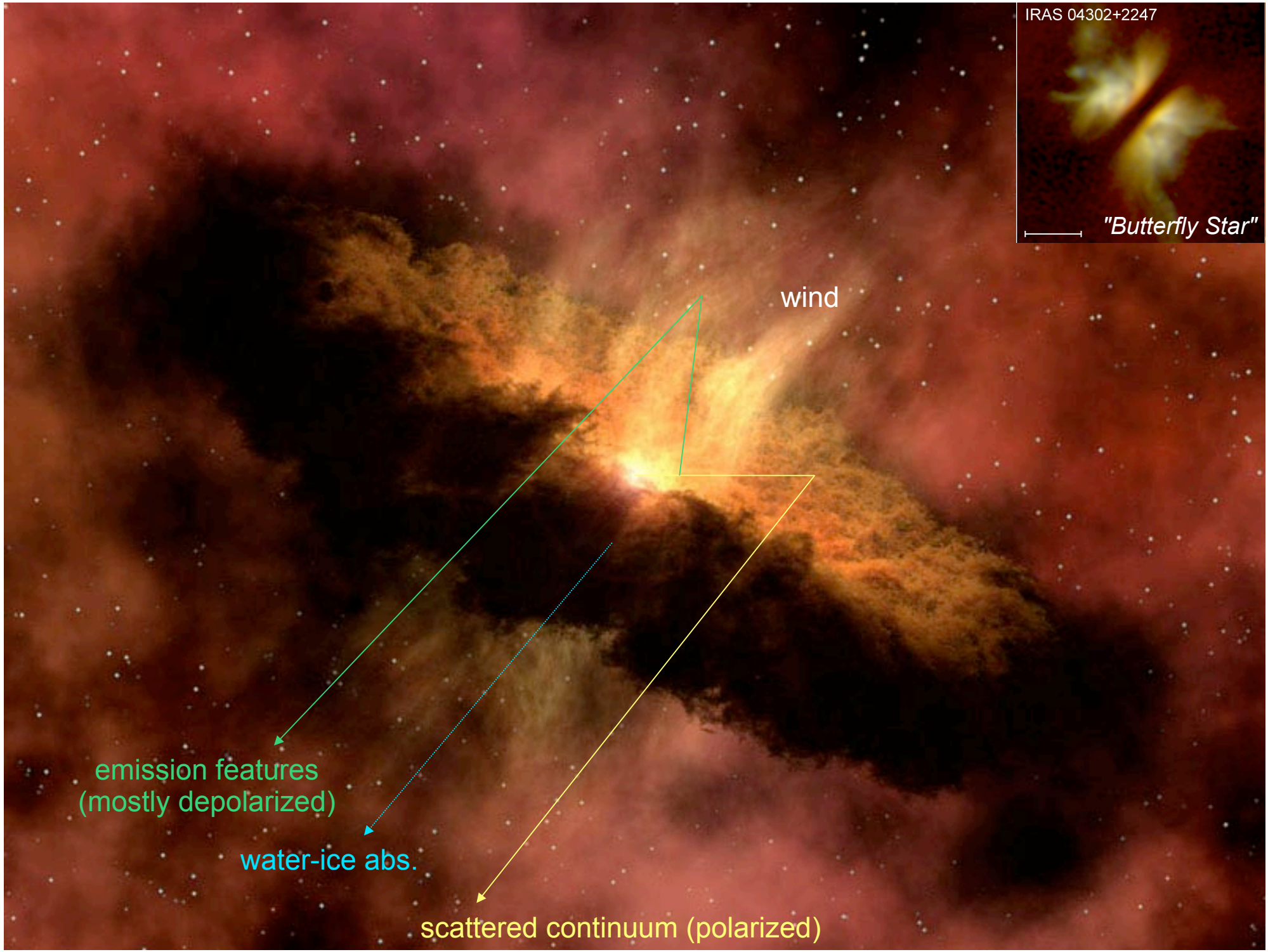
- the lines arise in a wind of the central giant



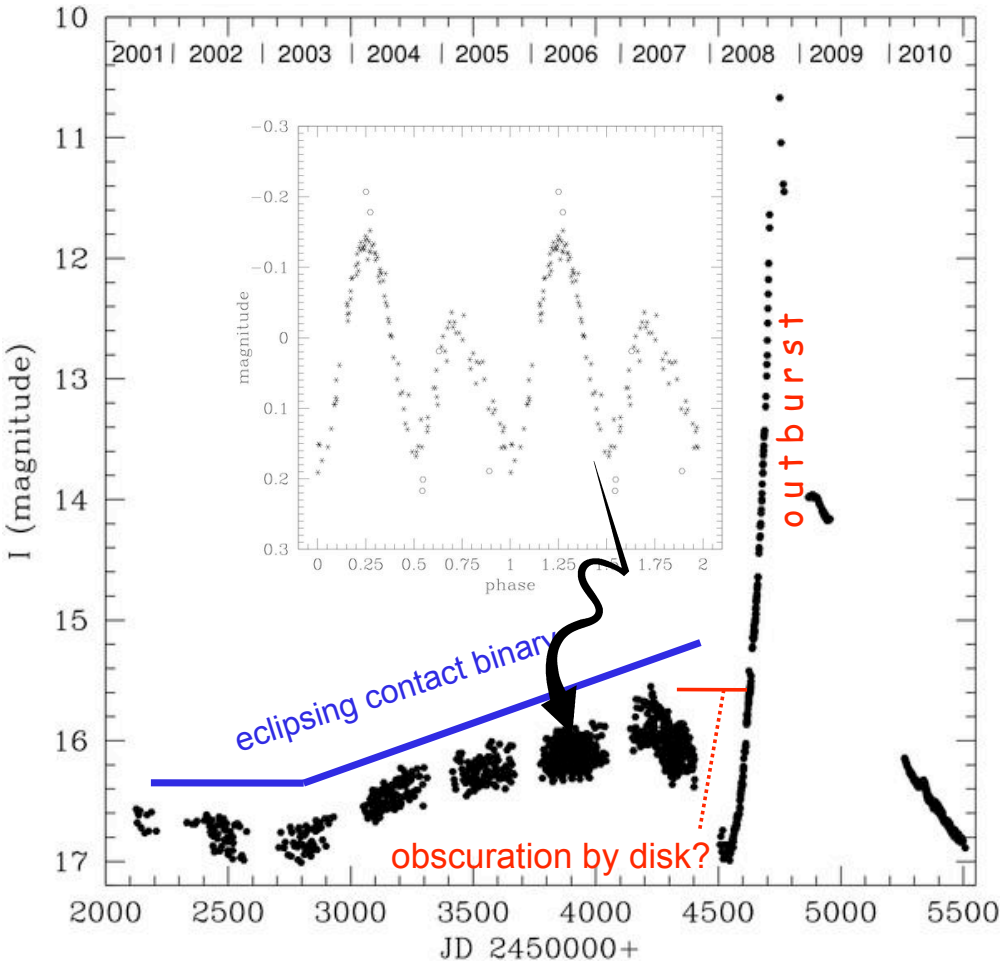
disk vs disk-wind line profiles
Murray & Chiang 1996

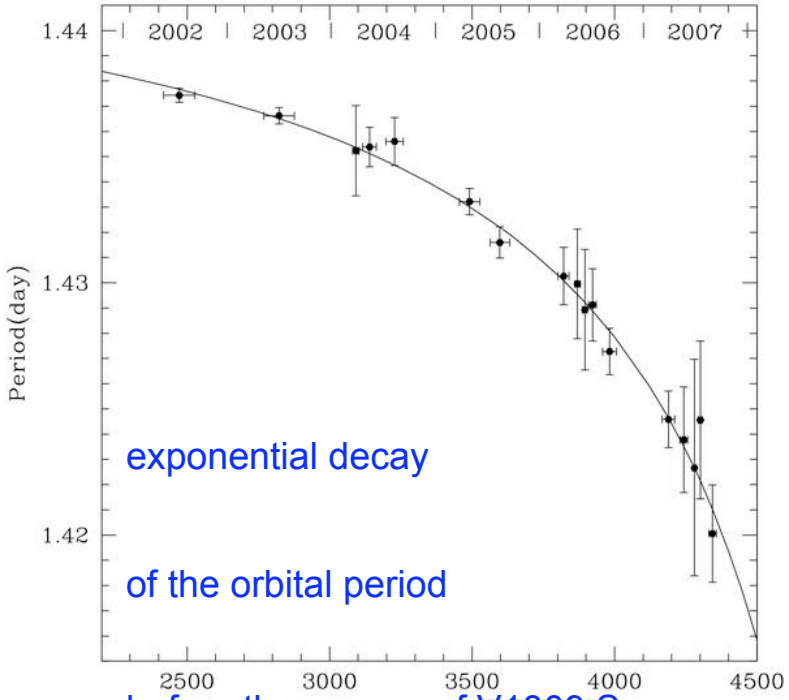
Spectropolarimetry of V4332 Sgr



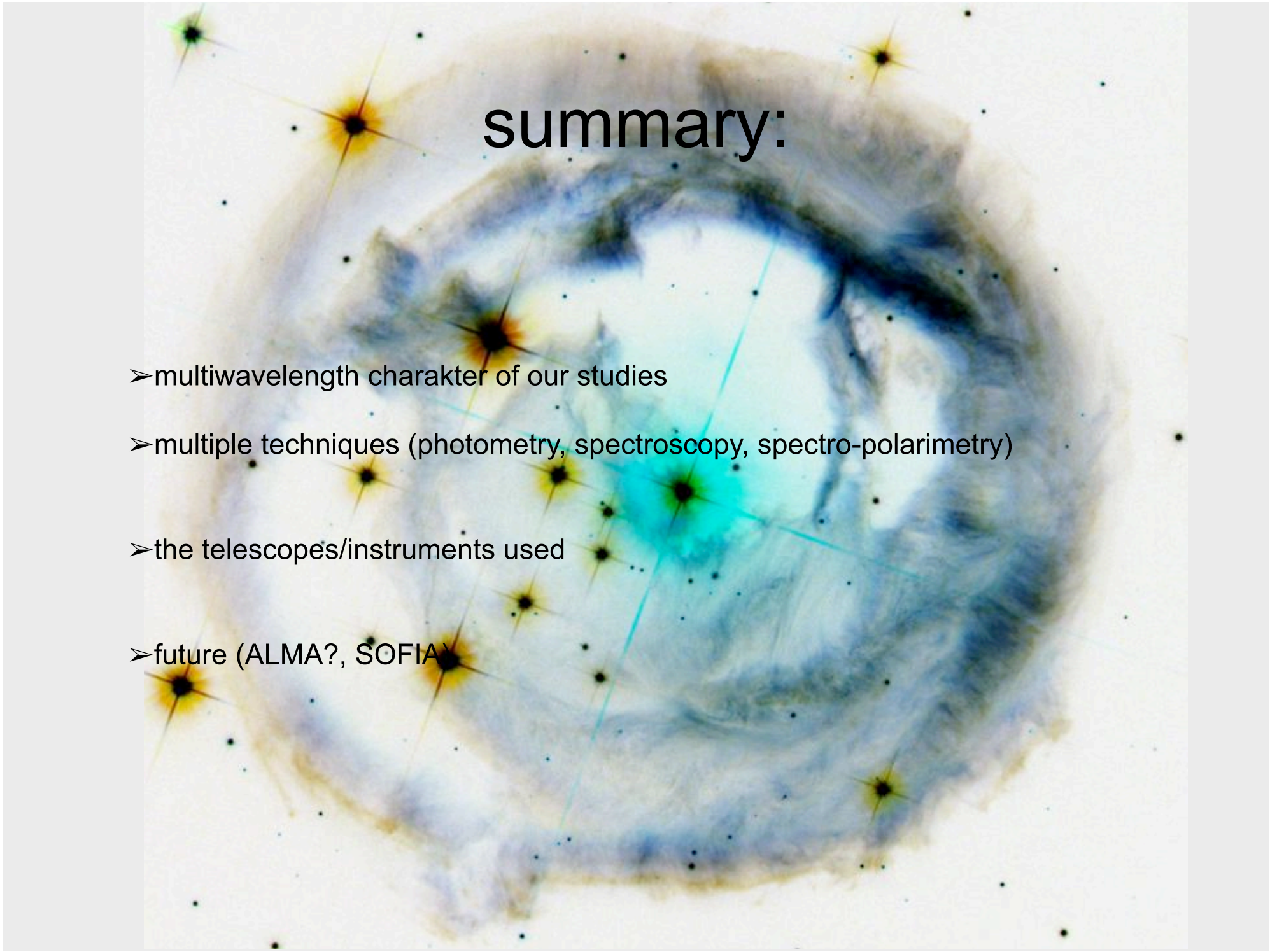

IRAS 04302+2247
"Butterfly Star"
wind
emission features
(mostly depolarized)
water-ice abs.
scattered continuum (polarized)

V1309 Sco





before the merger of V1309 Sco



summary:

- multiwavelength charakter of our studies
- multiple techniques (photometry, spectroscopy, spectro-polarimetry)
- the telescopes/instruments used
- future (ALMA?, SOFIA)