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Modeling Nova Delphini 2013

4th international TIGRE Workshop

Uni. de Guanajuato

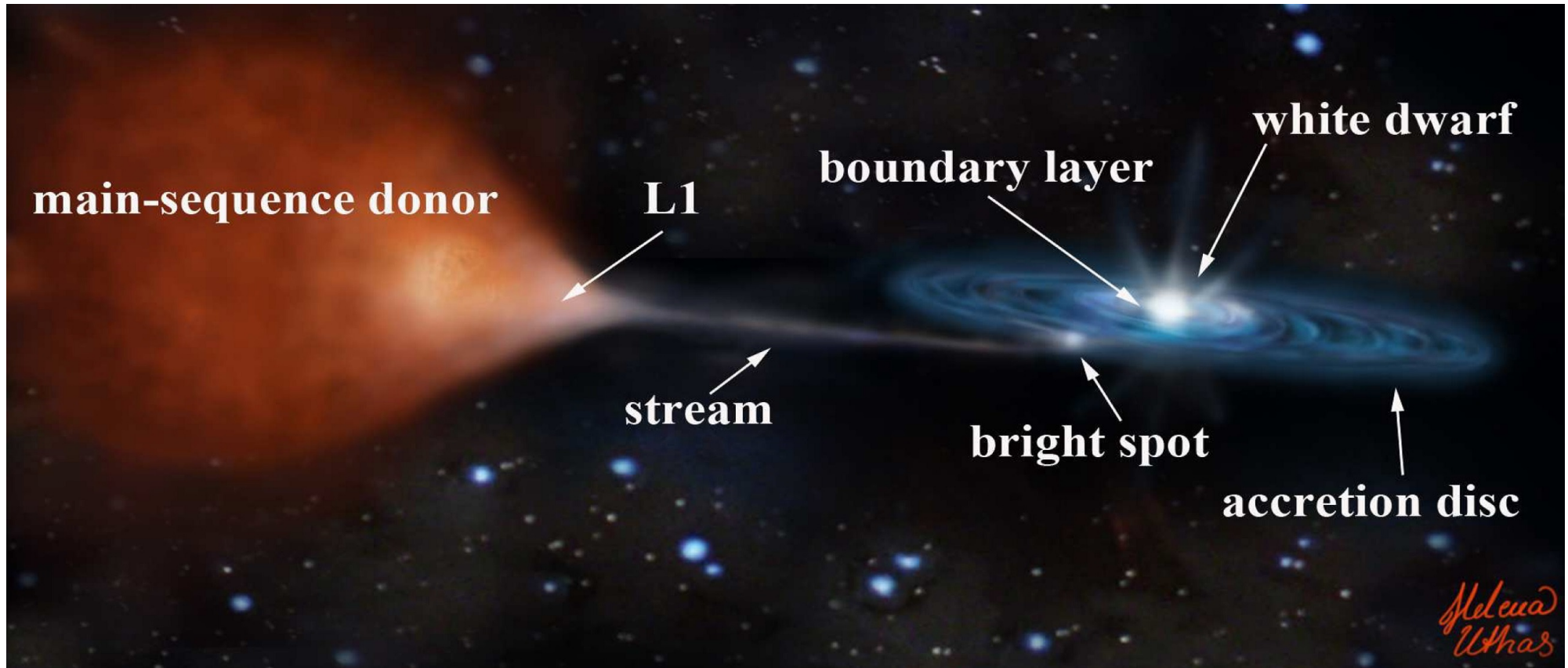


Novae?

PHOENIX models?

Preliminary results

Conclusions and outlook



[Helena Uthas, PhD thesis]

$$\Delta V \sim 10^m \text{ [} \Delta t \sim 1 \text{ day]}$$

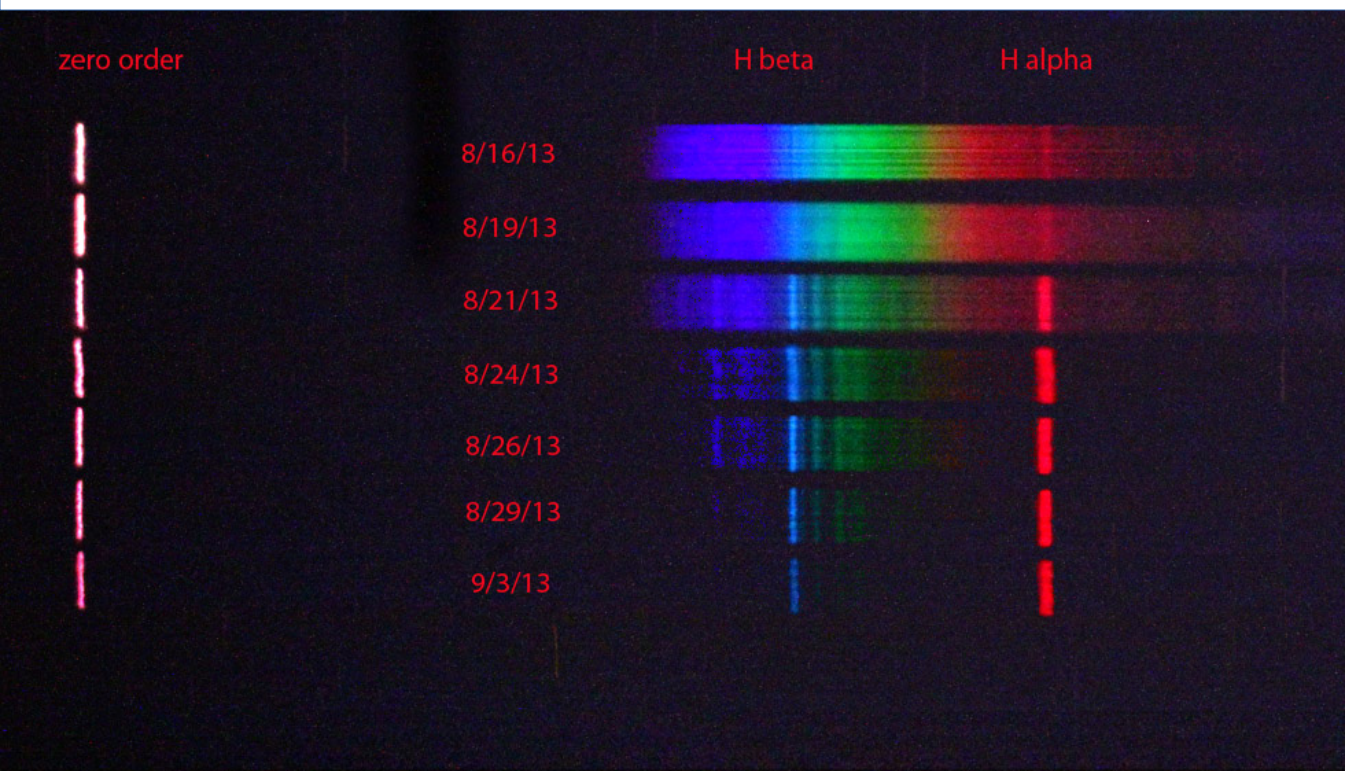
$$L \lesssim 10^5 L_{\text{Sun}}$$

$$M_{\text{ej}} \sim 10^{-4} - 10^{-5} M_{\text{Sun}}$$



Nova Del 2013 - 17.08.2014 (+3d) [K.P.Schröder]

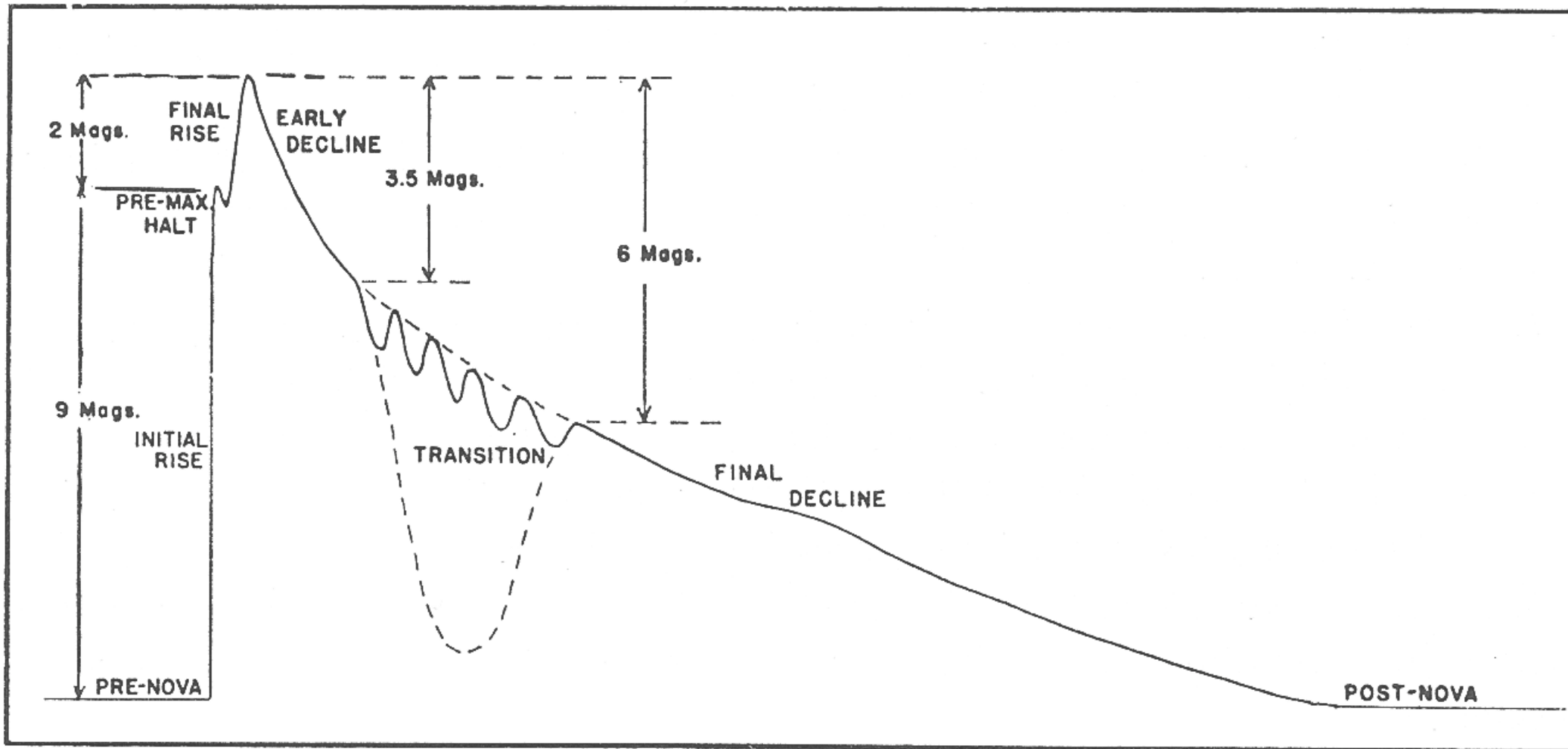
V339 Delphini (aka Nova Delphini 2013)



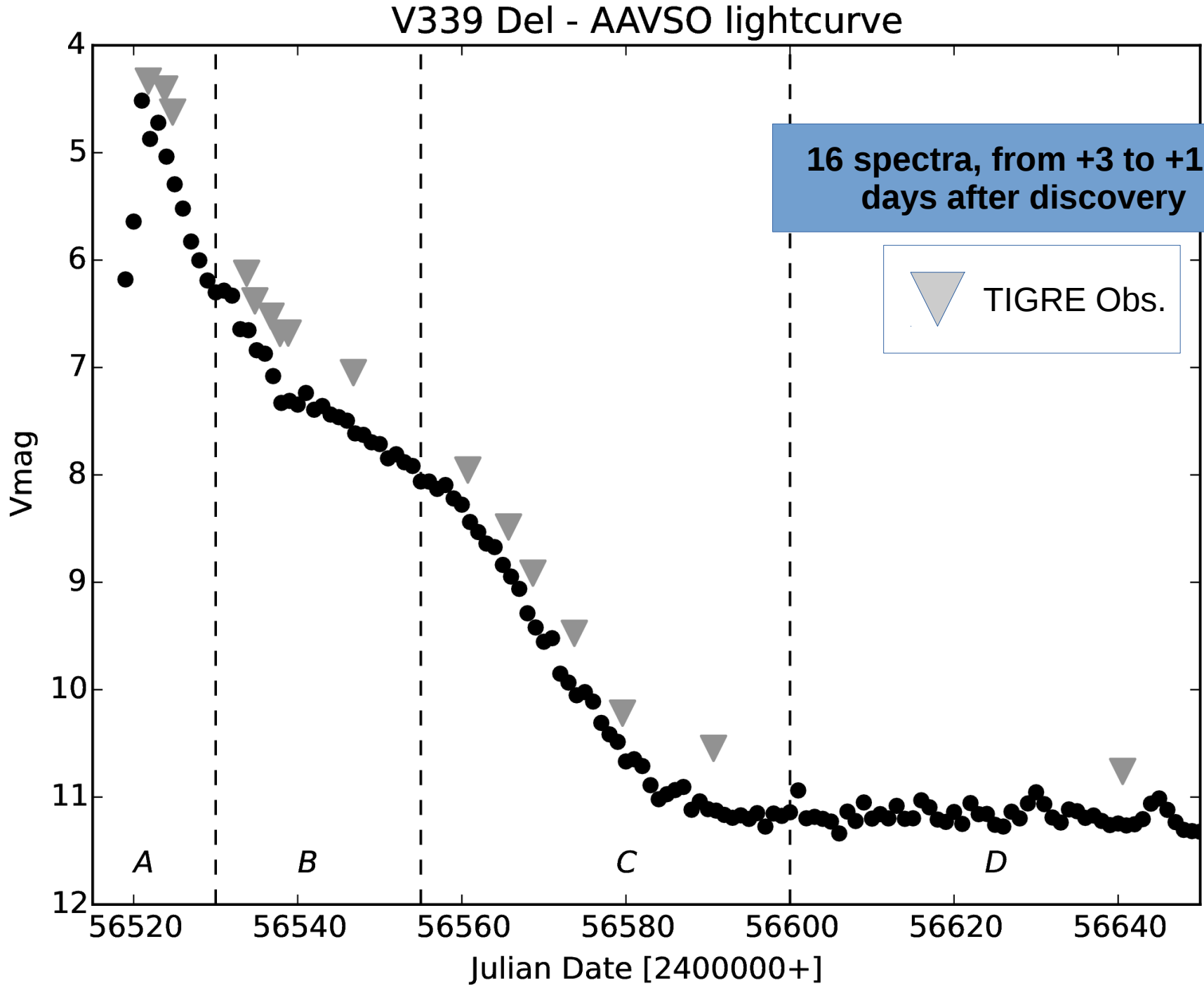
august 15th

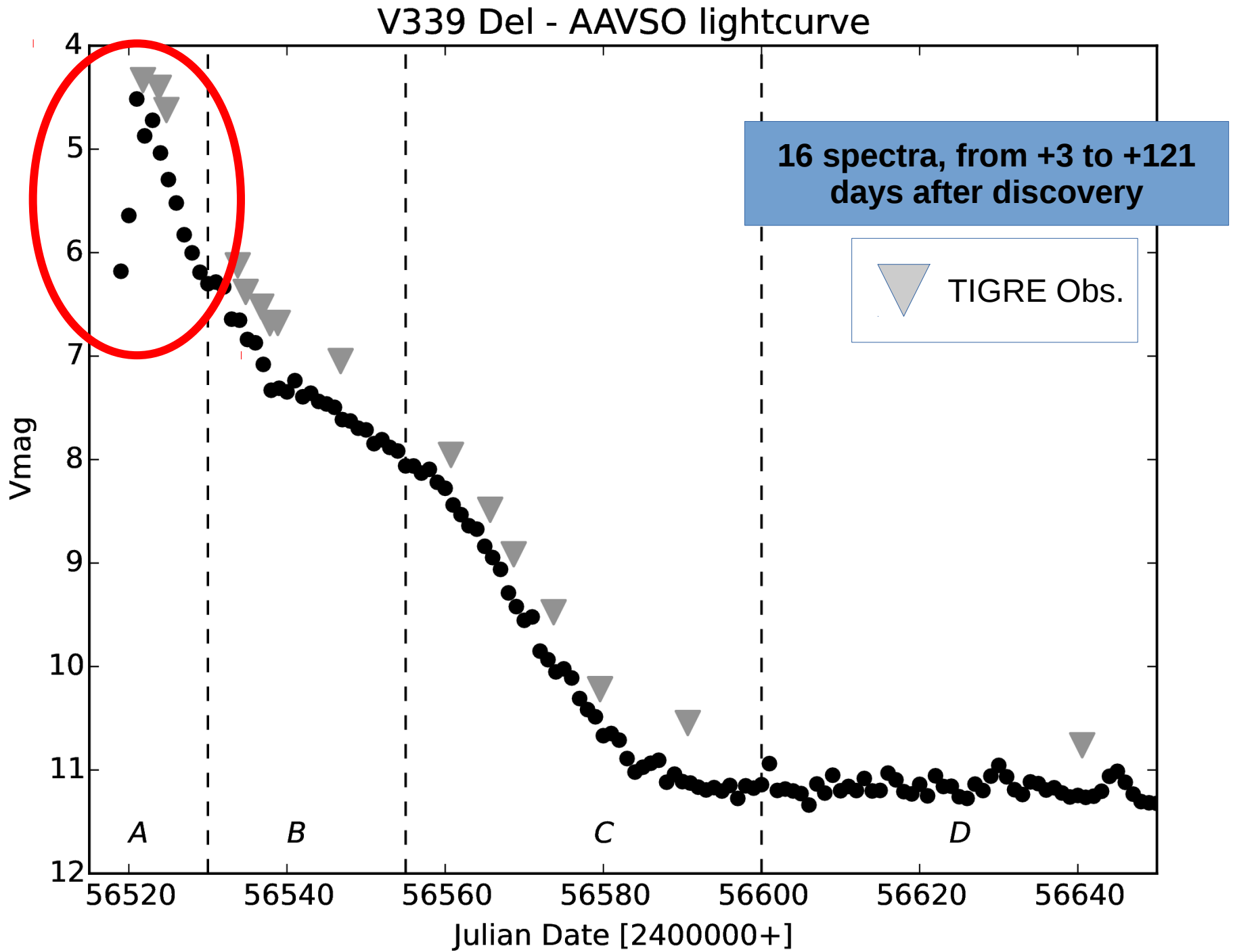
Nova Delphini 2013 changes color

september 2nd



McLaughlin (1939),
Payne-Gaposchkin (1957)





Very optically thick

Lots of P Cyg and absorption lines

Temperature increases with time

Freely expanding

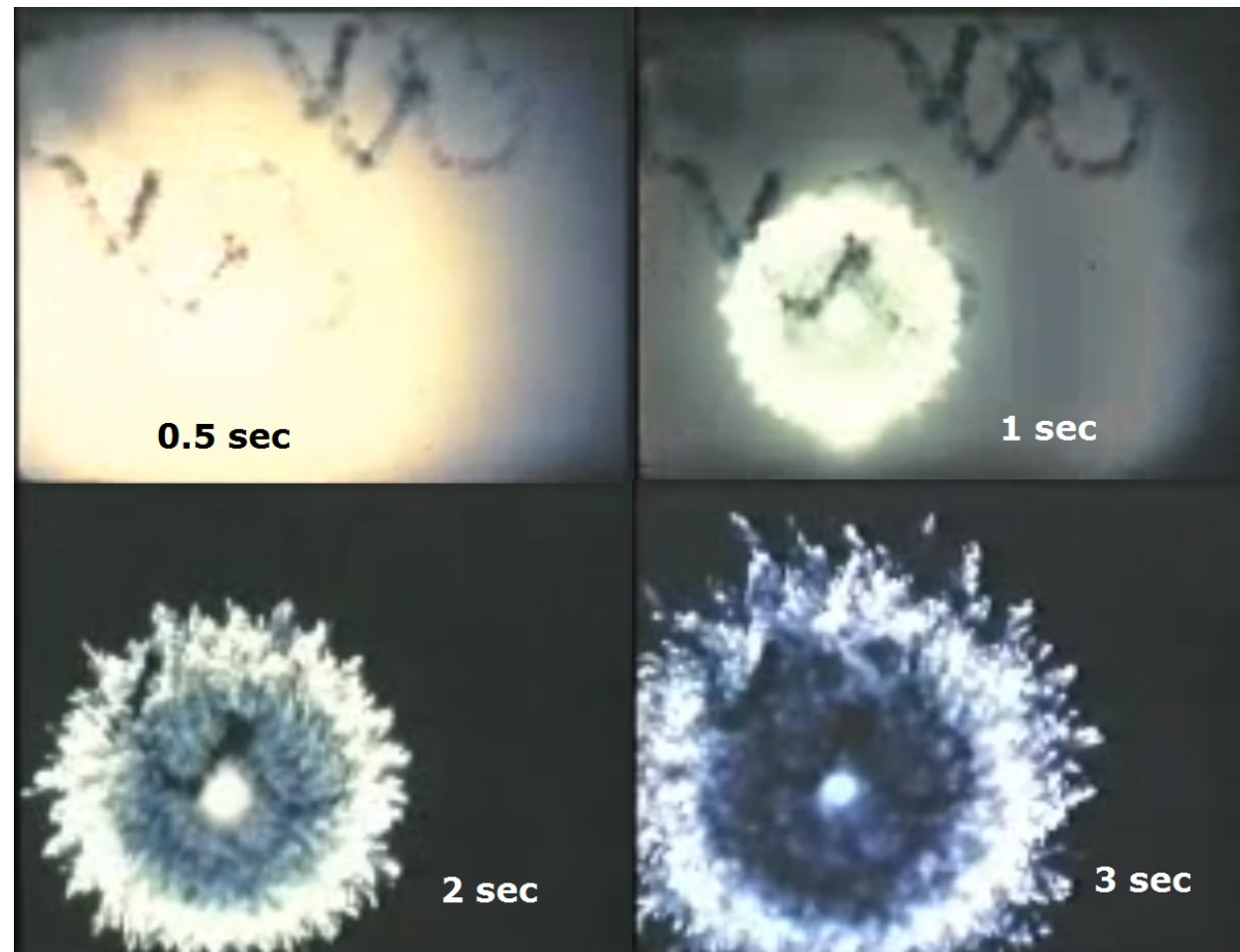
$\tau \downarrow$

Photosphere shrinks

$T \uparrow$

Ionization \uparrow

→ Nebular conditions



[Starfish test in 1962, 400 km above Johnston Atoll]

However...

- Concept of photosphere?
- Very wide, expanding atmosphere: $R_{\text{in}}/R_{\text{out}}$ from 100 to 1000 (giants have ~2-5)
- Density is not that high → rad.rates dominate over coll.rates → NLTE

And honestly...

- Spherical symmetry - NO **but...**
- Time independent - NO **but...**
- Freshly produced radioactive isotope - YES **but...**

Therefore: relativistically expanding, spherically symmetric, stationary atmosphere.

Can we model this?

A multi-purpose atmospheric code
(Hauschildt, Baron, Allard, Barman et al.)

Supernovae I & II

Novae

A-M dwarfs and giants (with winds)

Brown dwarfs and planets

AGN and proto-planetary disks

Two geometrical implementations

- 1D – plane-parallel / spherically symmetric expanding atmosphere (*this work*)
- 3D – fixed structure (P, T, ρ) in spherical/cylindrical/cartesian coordinates

PHOENIX micro physics

Atmosphere radial structure in any flavor

RT: LTE/NLTE lines, continua, scattering

Lines lists: atomic and molecular databases (total $\sim 10^7$ atomic lines, $\sim 10^9$ molecular lines)

EOS: large range of temperature including atoms, molecules and dust

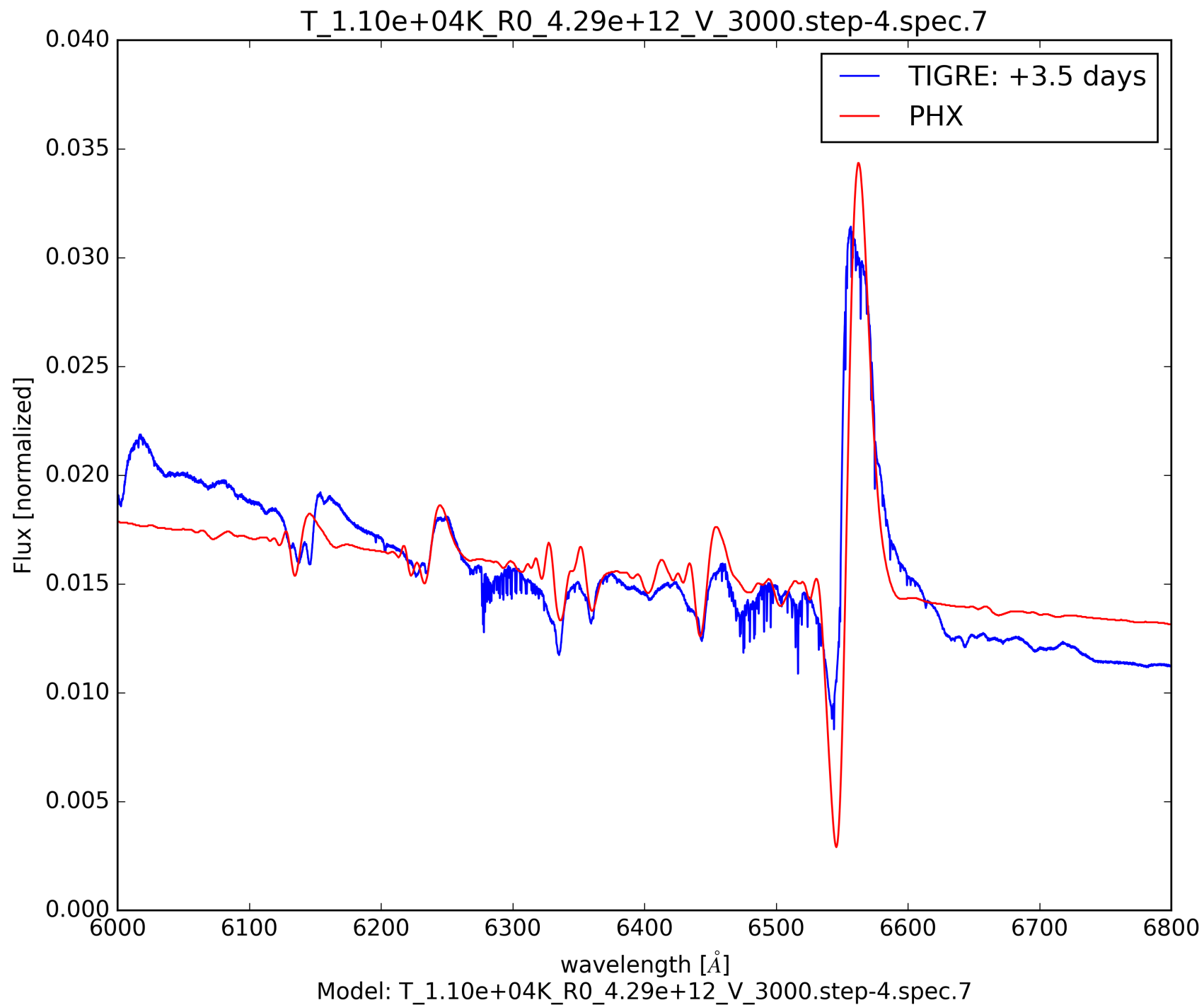
From early work (Hauschildt et al.):

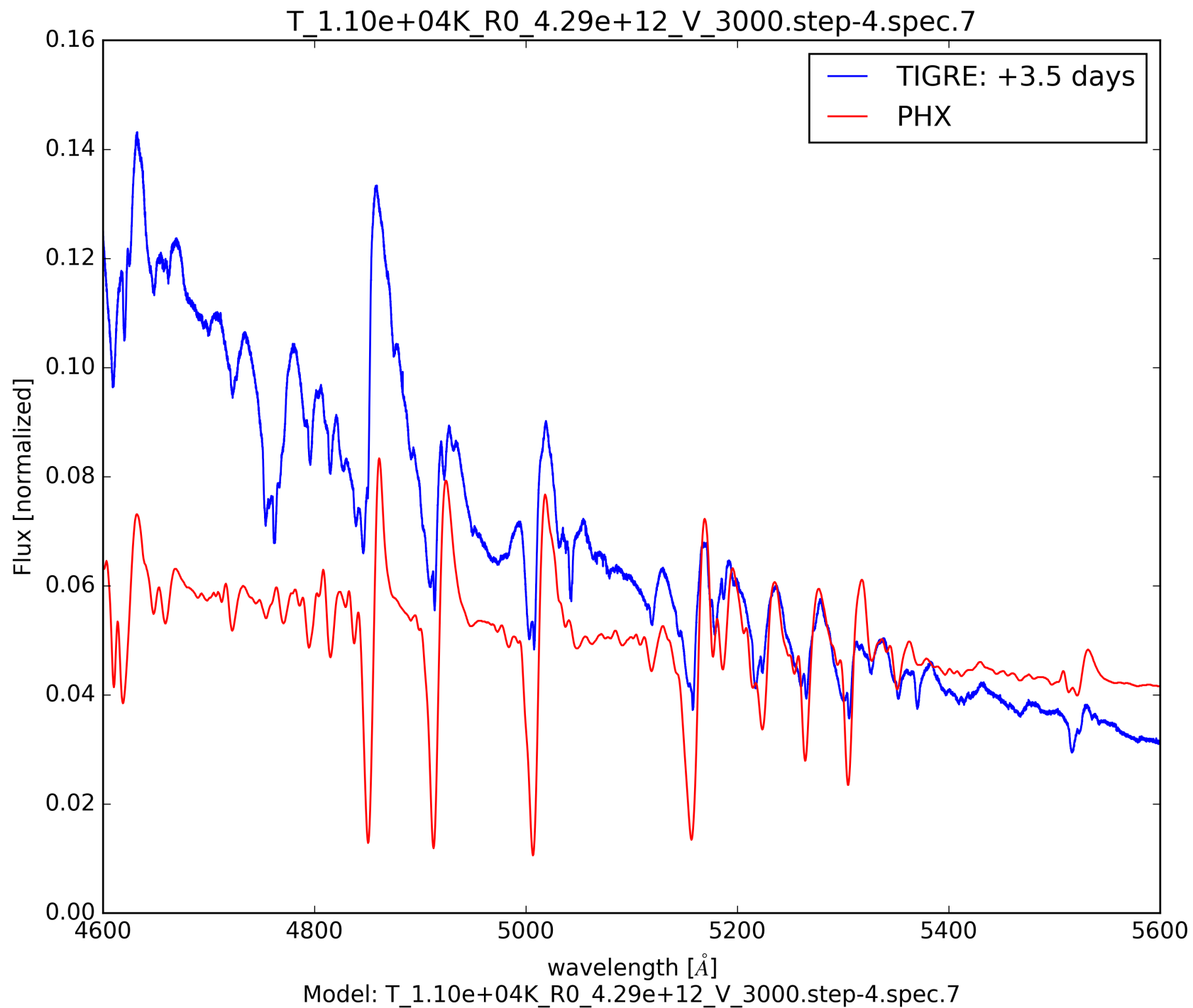
- R does not influence much: R_{in}/R_{out} but especially T are the most important parameters
- NLTE treatment fundamental (Fe group ions)
- **Lots** of overlapping lines (“iron curtain”)
- Continuum? It's mostly weak lines

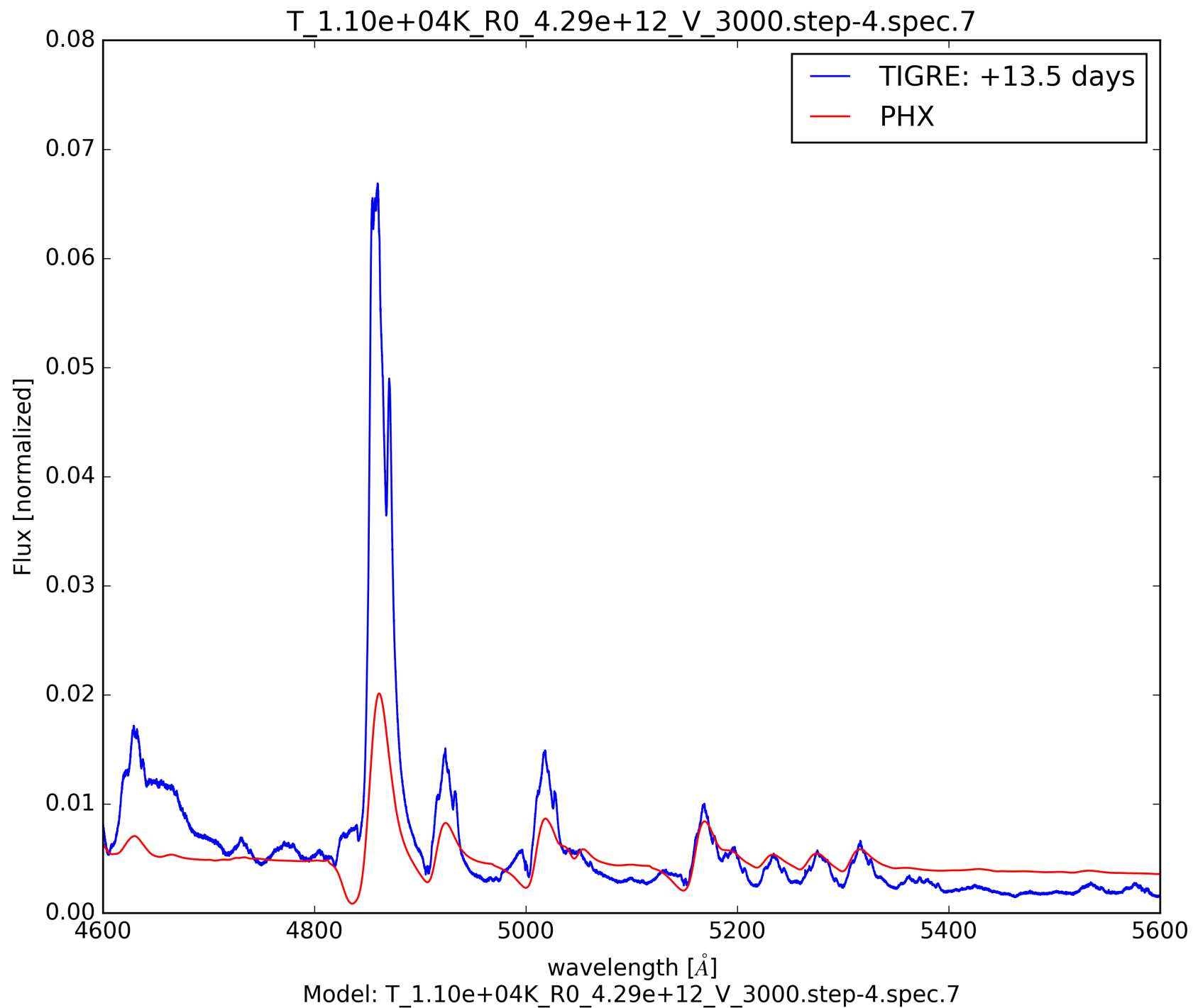
Grid parameters

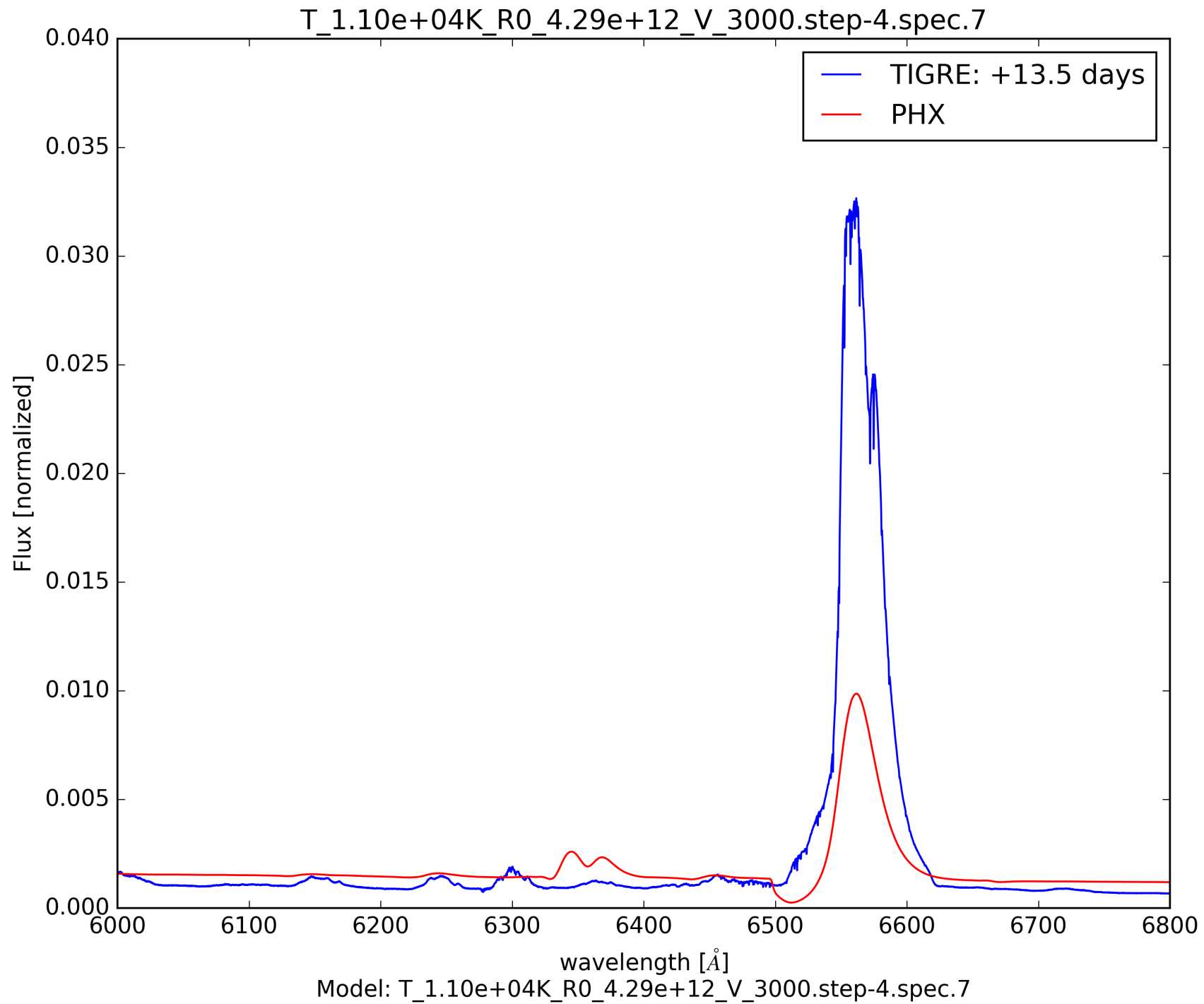
- Temperature
- Velocity
- Radius
- Outer density
- Metallicity [$z \uparrow$ then $T \uparrow$ + degeneracy]
{never heavily investigated}

j For each model ~1000 CPU hours !









So far:

- Temperature constrained < 14000 K (for z_{Sun})
- Velocity ~ 2500 km/s
- Radius not important

To add:

- Outer densities
- Different metallicities

Publicly available? Why not!