Recent Progress in Modelling of Accretion Discs in AM CVn Stars

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Outline

- Modelling of NLTE Accretion Discs
- Model grid for AM CVn systems
- Model vs. CE 315
- Accretion Disc Wind – First Steps
- Summary

Modelling of NLTE Accretion Discs

- Assumptions:
  geometrically thin α-disc (Shakura & Sunyaev 1973)
  axial symmetry
- Divide disc into set of concentric rings
- Each ring: plane-parallel radiating slab
- Calculate detailed vertical structure and synthetic spectrum with AcDc (Accretion Disc code, Nagel et al. 2004)

Modelling of Accretion Discs

- **hydrostatic equilibrium**
  (gas and radiation pressure)
- **radiative equilibrium**
  (full line blanketing, no convection)
- **NLTE rate equations**
- **radiation transfer eqs.**
  (irradiation by primary can be considered)

Modelling of Accretion Discs

- Vertical structure and spectrum for each disc ring
- Integration of all disc ring intensities, rotational broadening

  $\Rightarrow$ NLTE accretion disc spectra for different inclinations
- disc spectrum can be used as input for our **accretion disc wind models**

Modelling of Accretion Discs

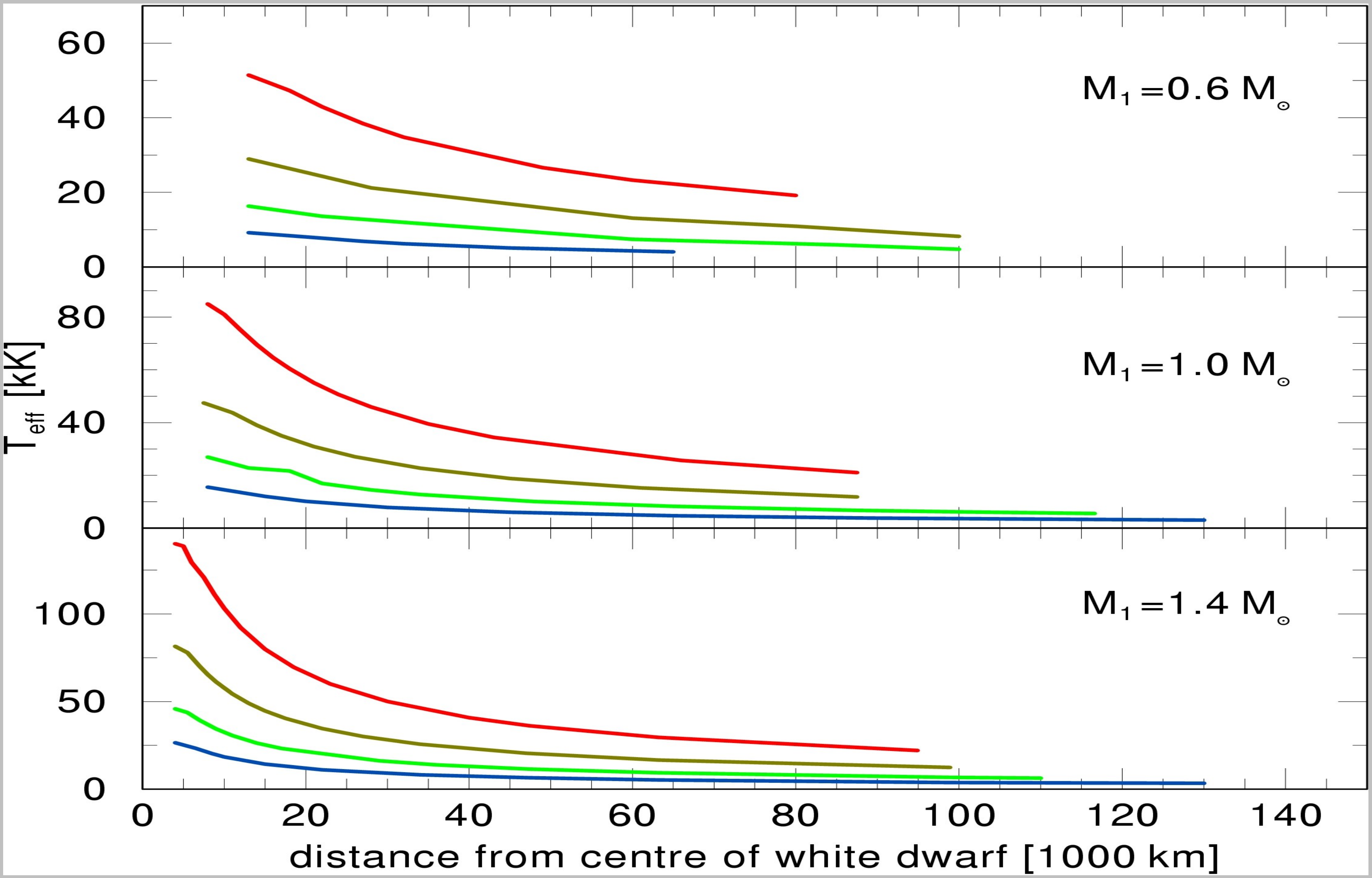
Input parameters

- mass and radius of central object
- mass accretion rate
- radial extension of accretion disc
- Reynolds number
- chemical abundances (→ donor star)
- irradiation: temperature/spectrum of central object
  irradiation angle

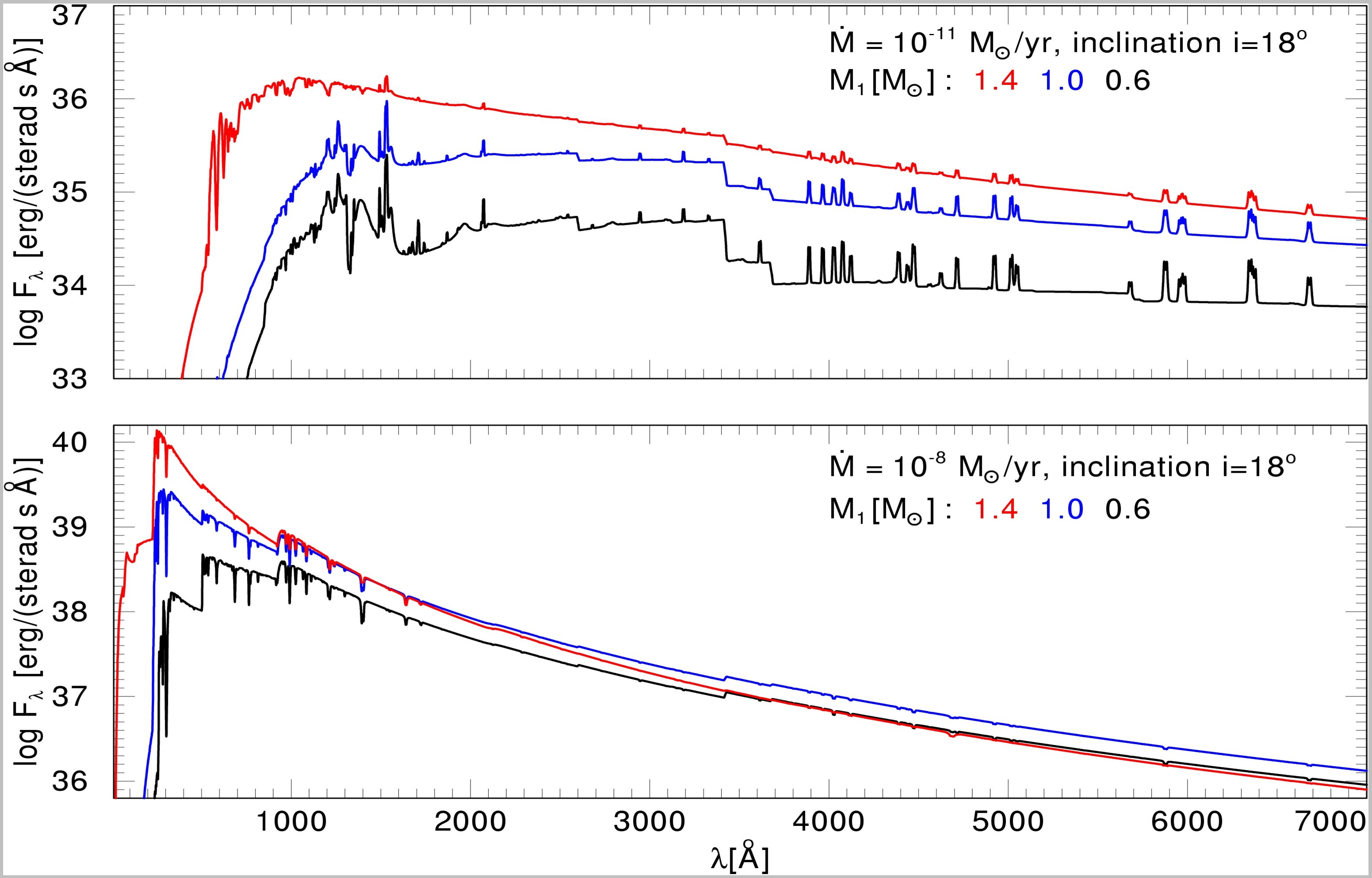
Model grid for AM CVn stars

- mass of primary: 0.6, 0.8, 1.0, 1.2 and 1.4 $M_{☺}$
- mass accretion rate: 10^{-8}, 10^{-9}, 10^{-10}, 10^{-11} $M_{☺}$/yr
- variation of C, N, O, Si abundances
- radially extended to the tidal radius (if possible)
- five inclination angles

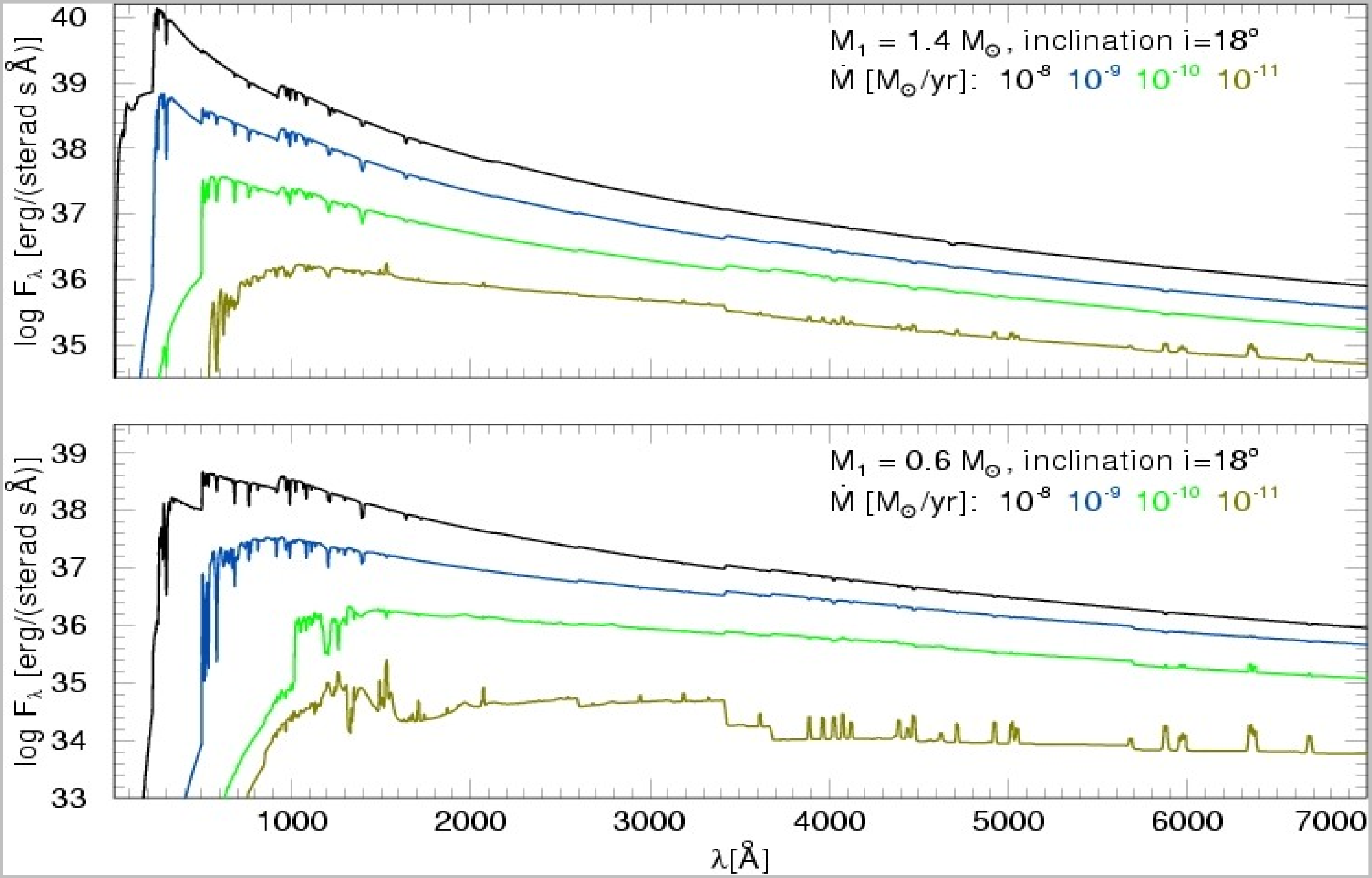
Model grid for AM CVn stars



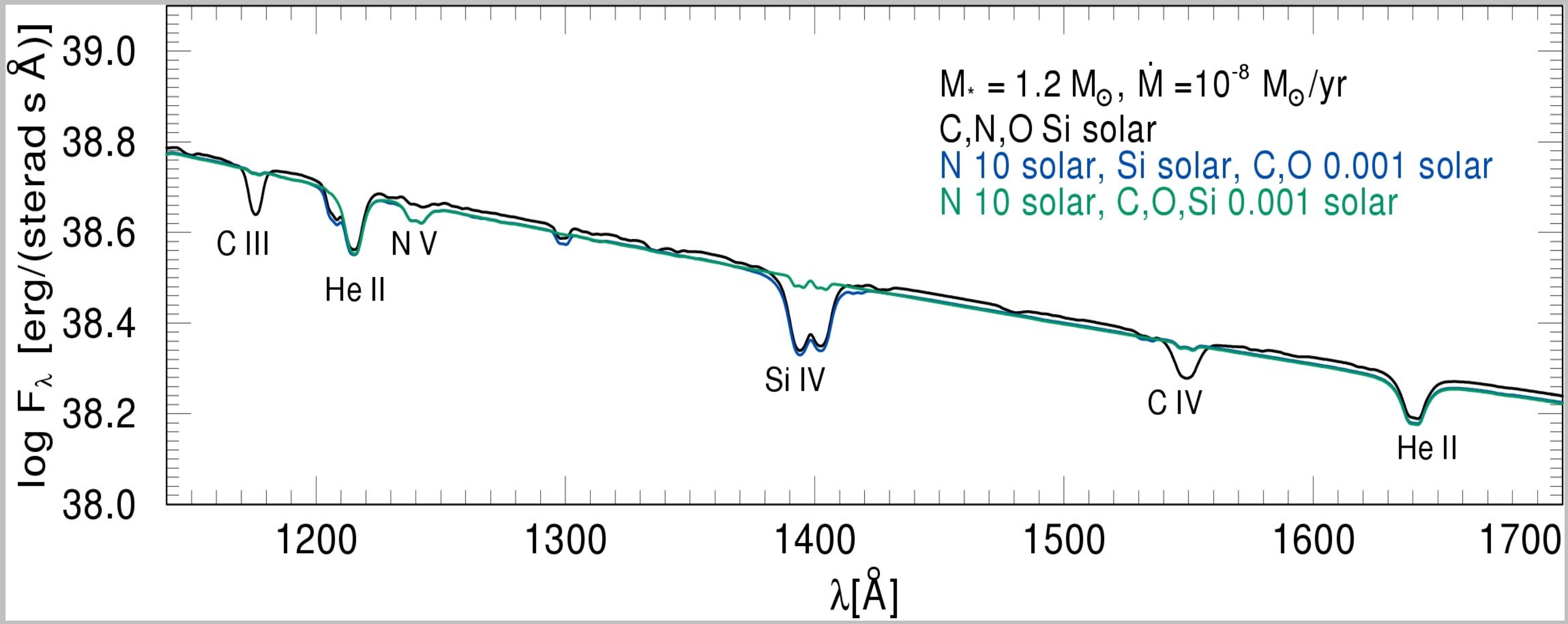
Variation of primary mass



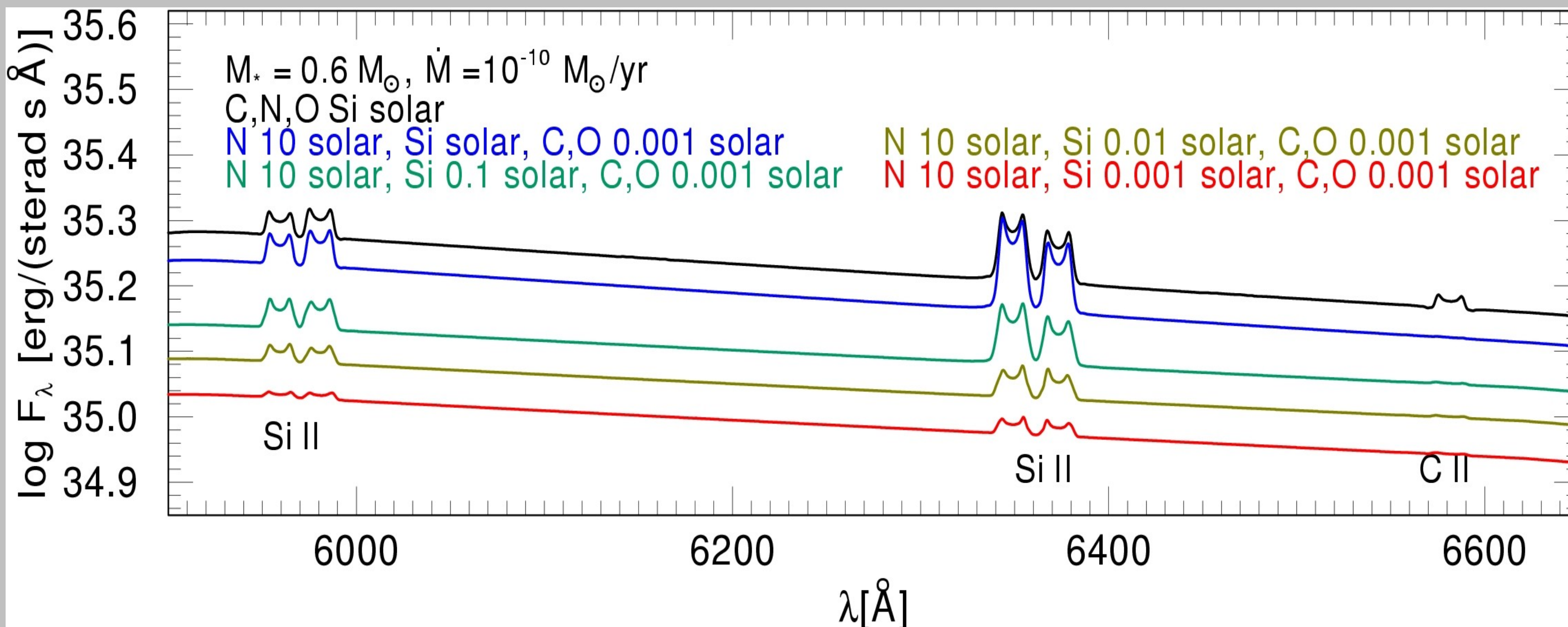
Variation of mass-accretion rate



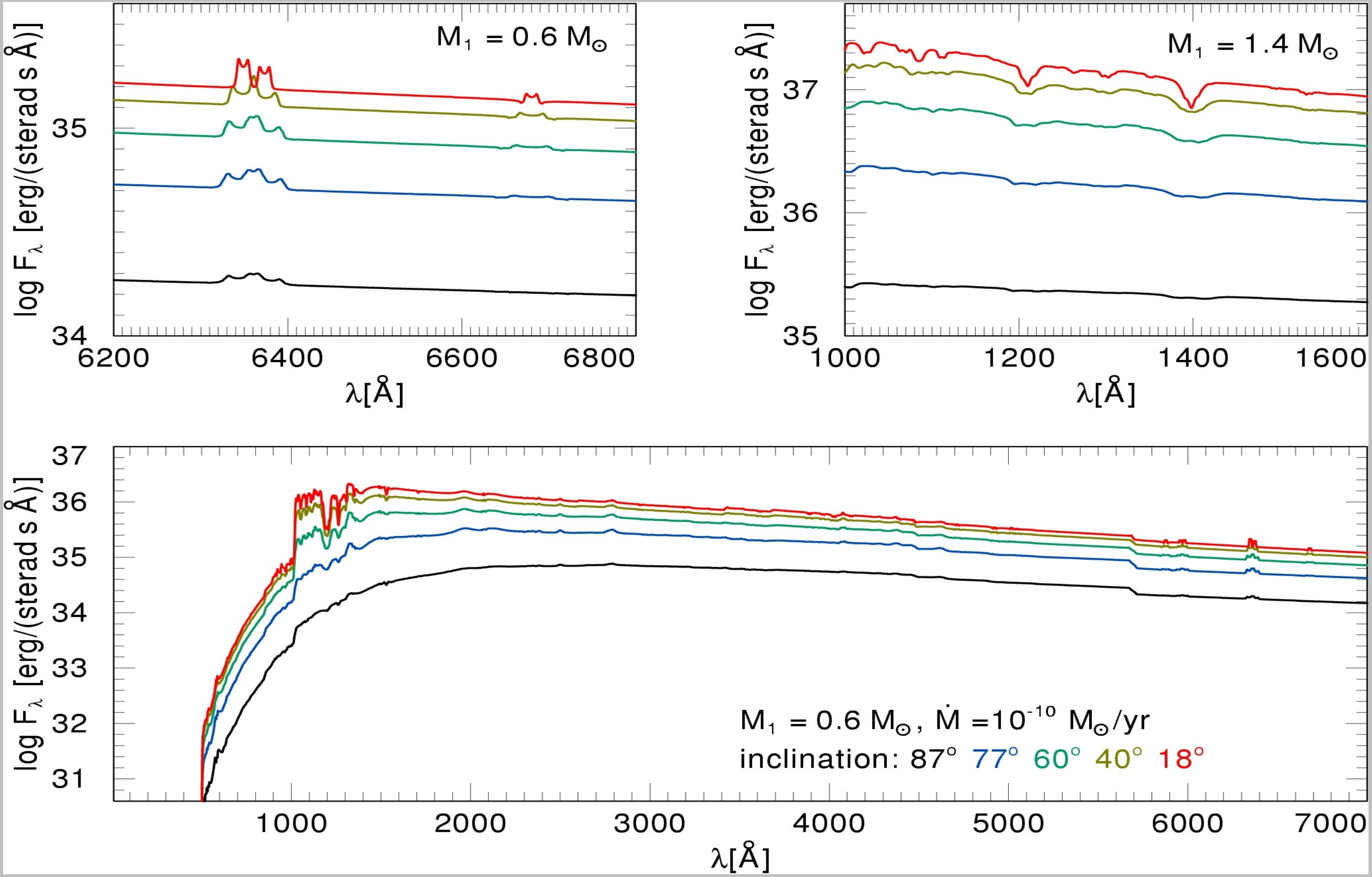
Variation of chem. abundances



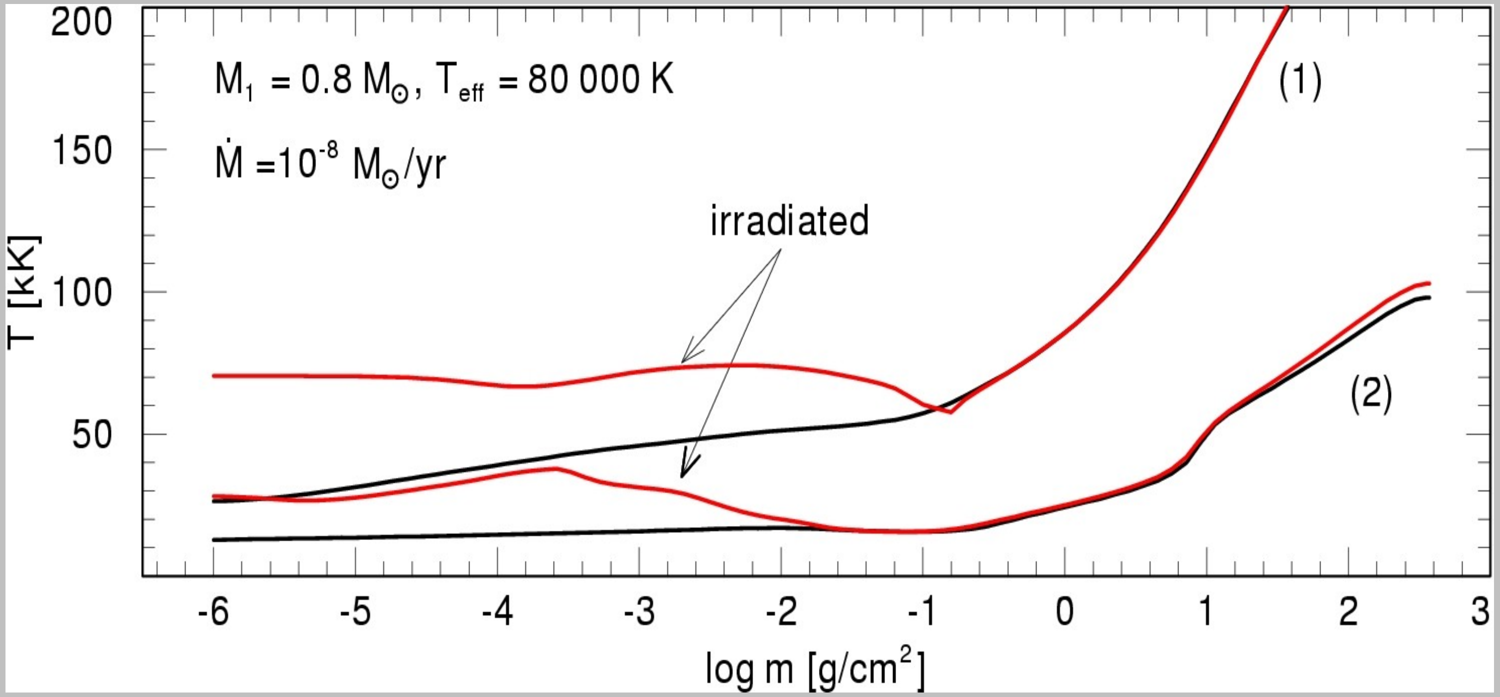
Variation of chem. abundances



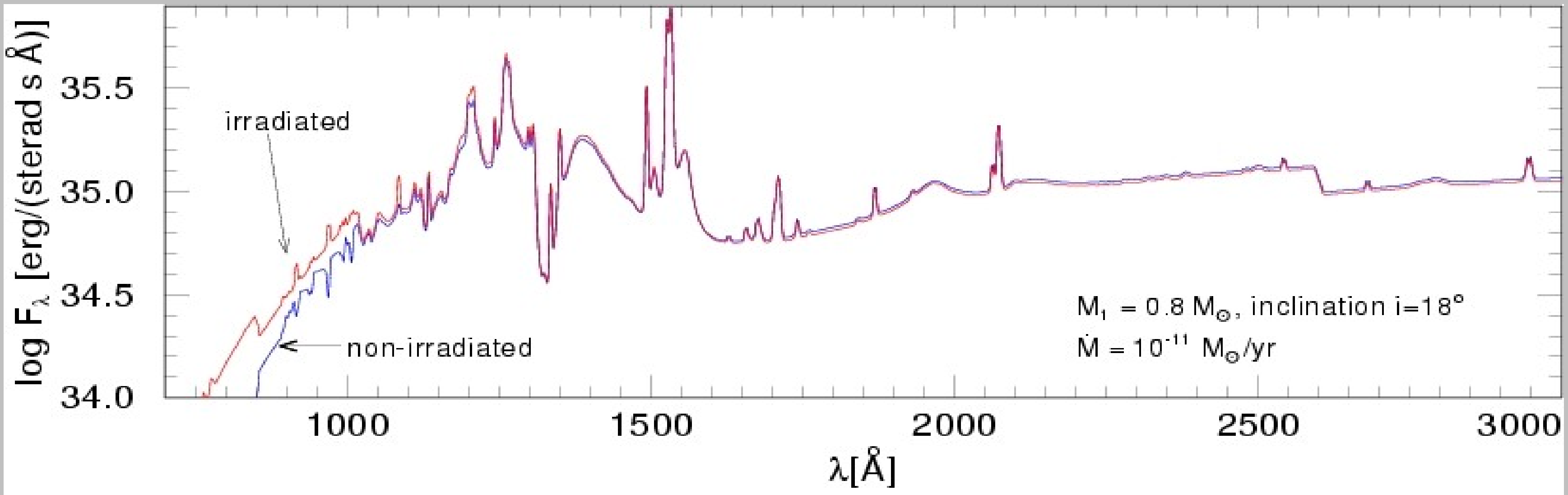
Variation of inclination

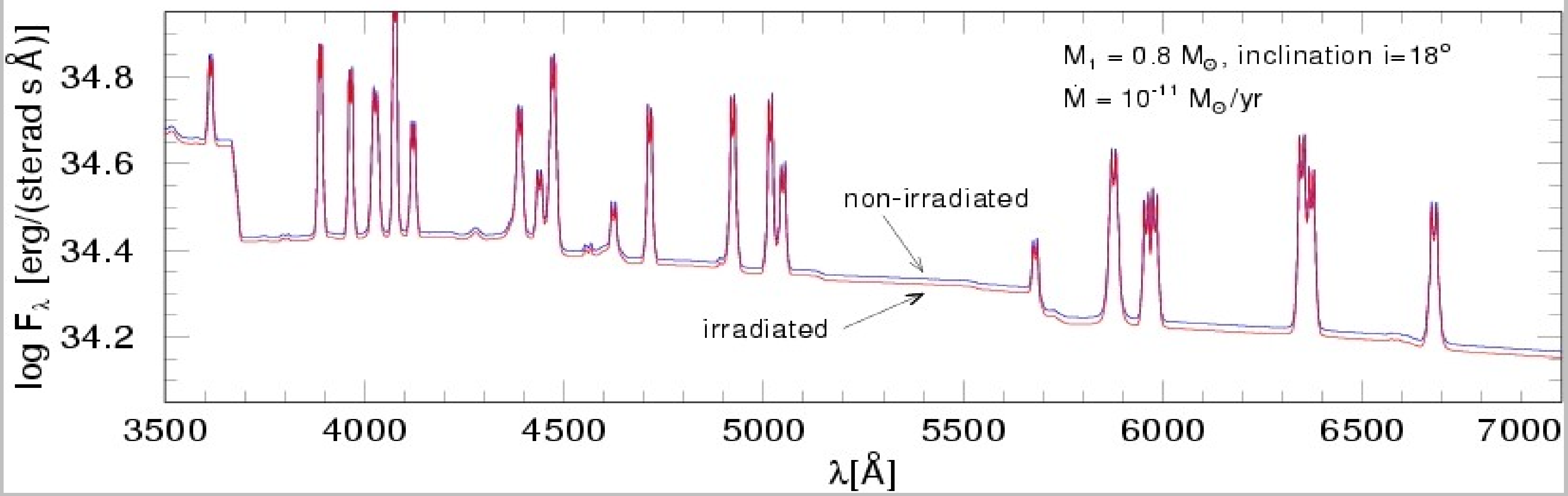


Influence of irradiation by primary



Influence of irradiation by primary



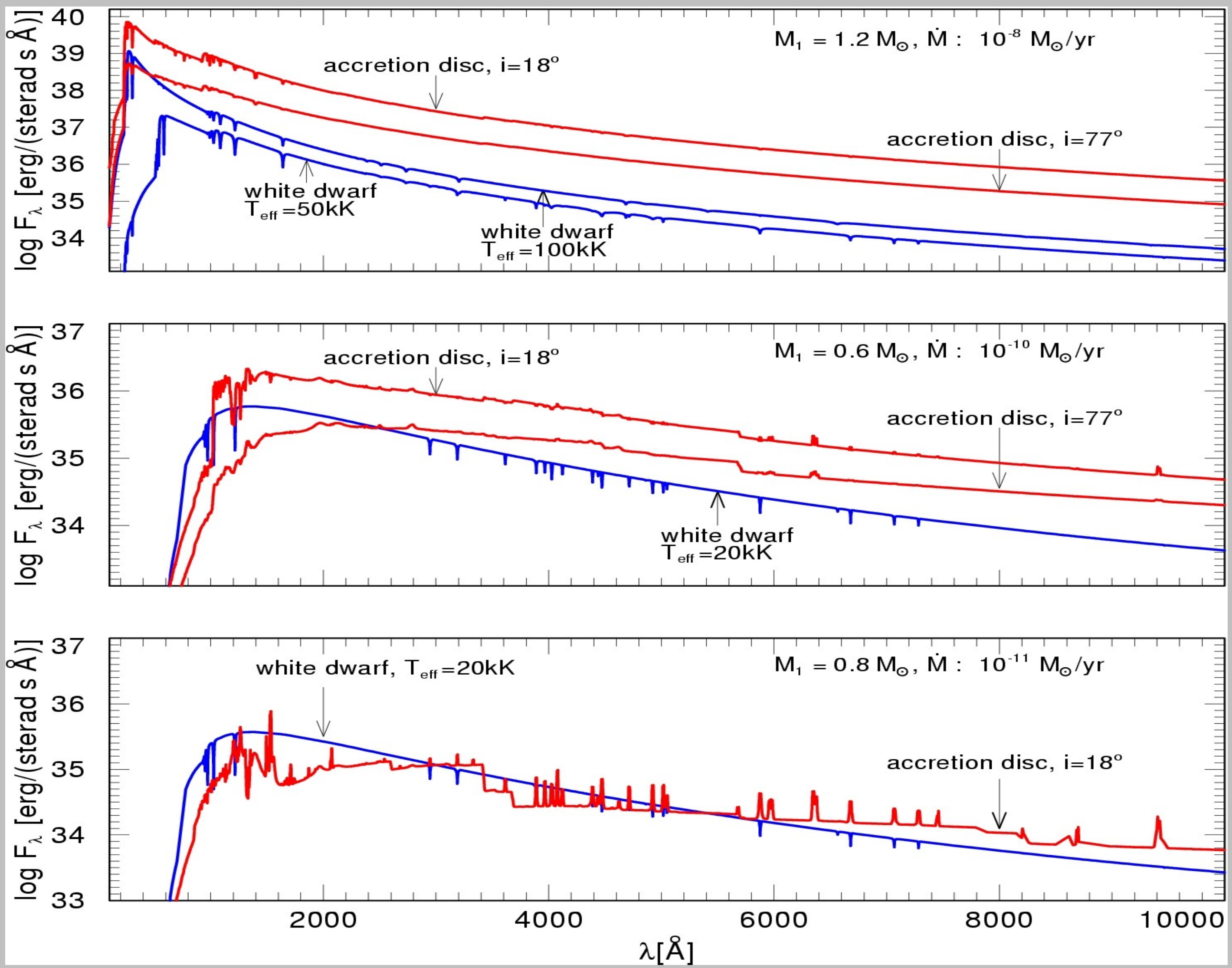


Spectroscopic detection of primary

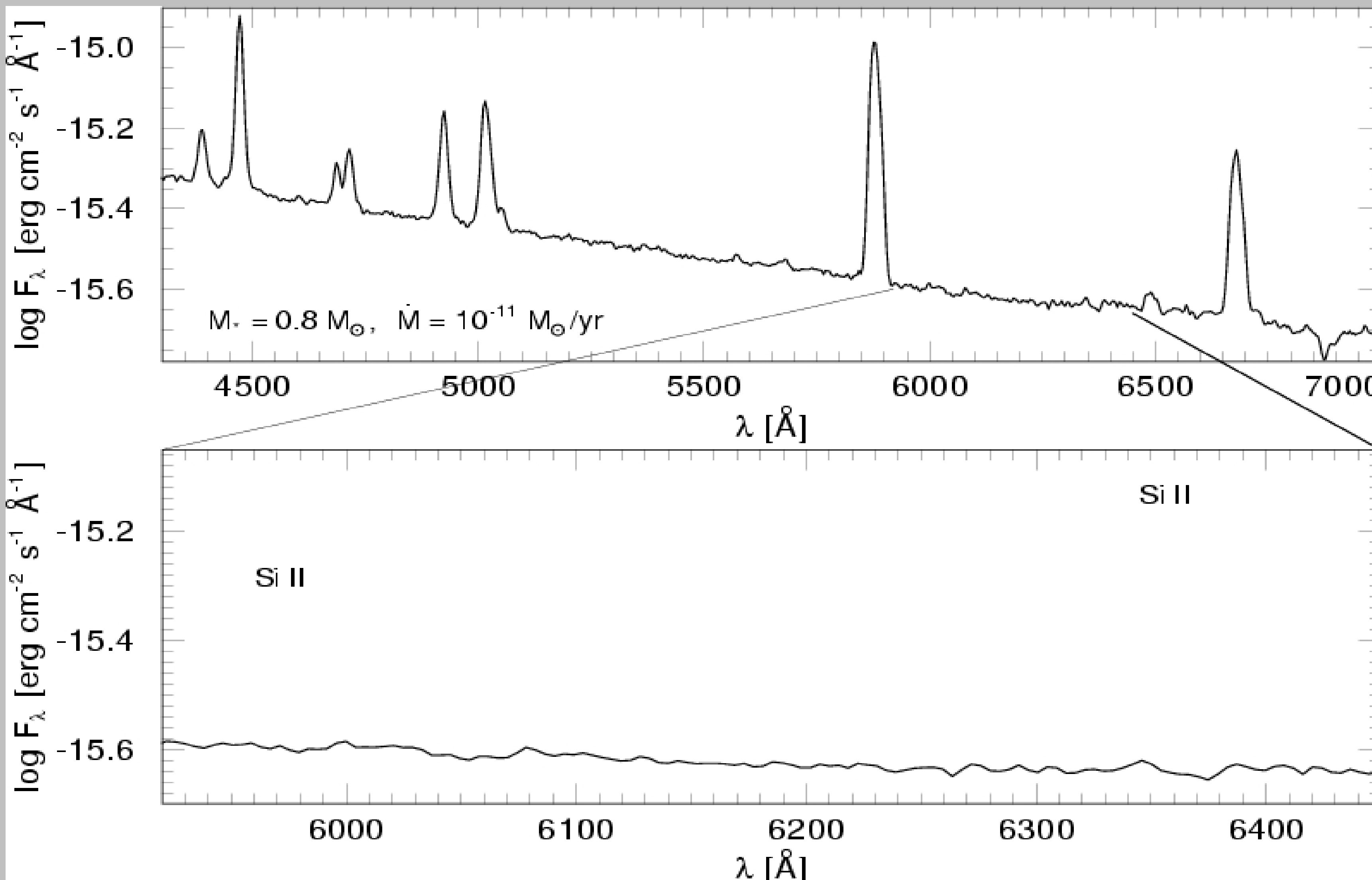
- so far only one directly spectroscopical detection of white dwarf primary (Sion et al. 2006)

- in which systems should we look, in which wavelength range ?

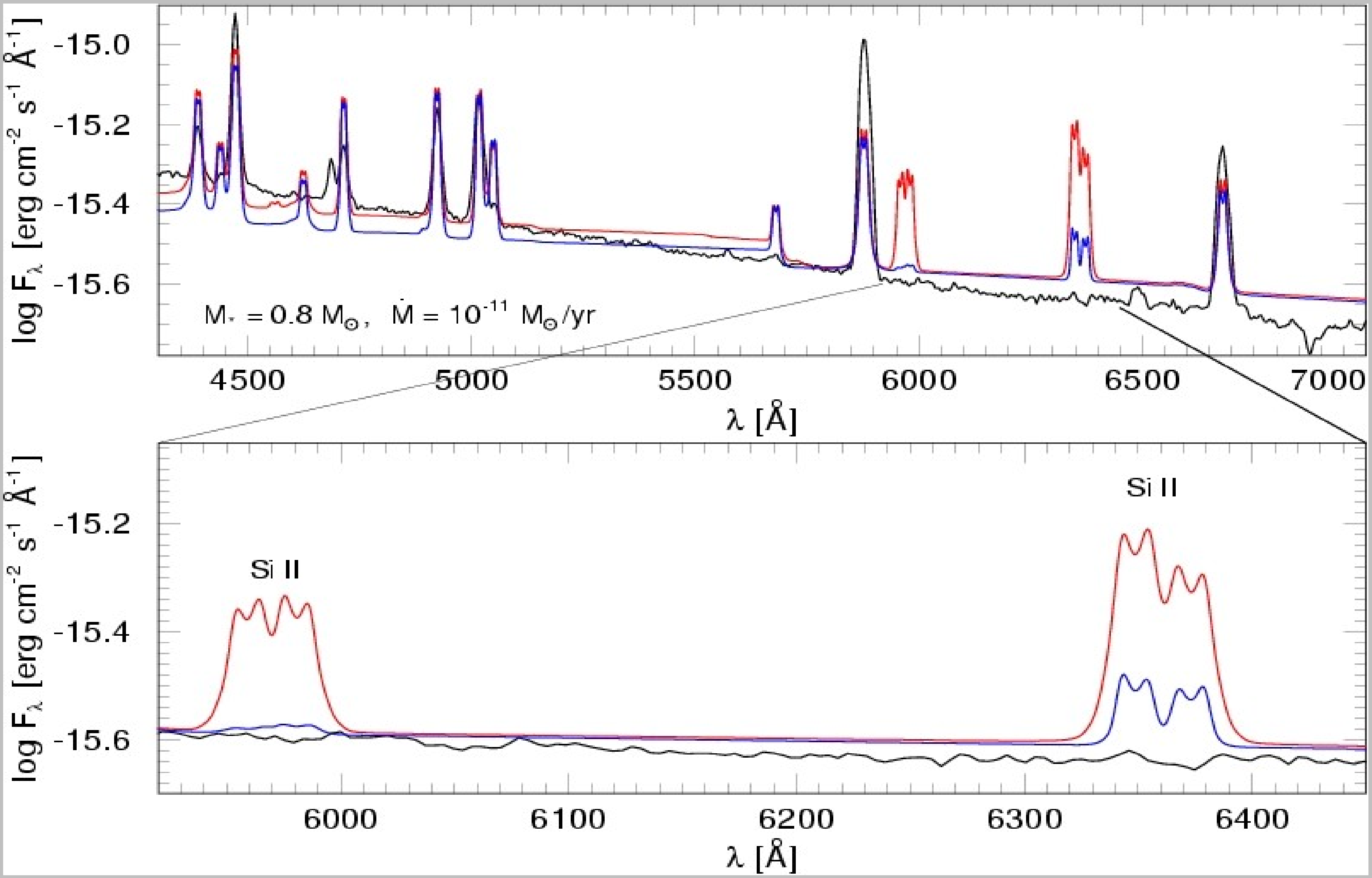
Spectroscopic detection of primary



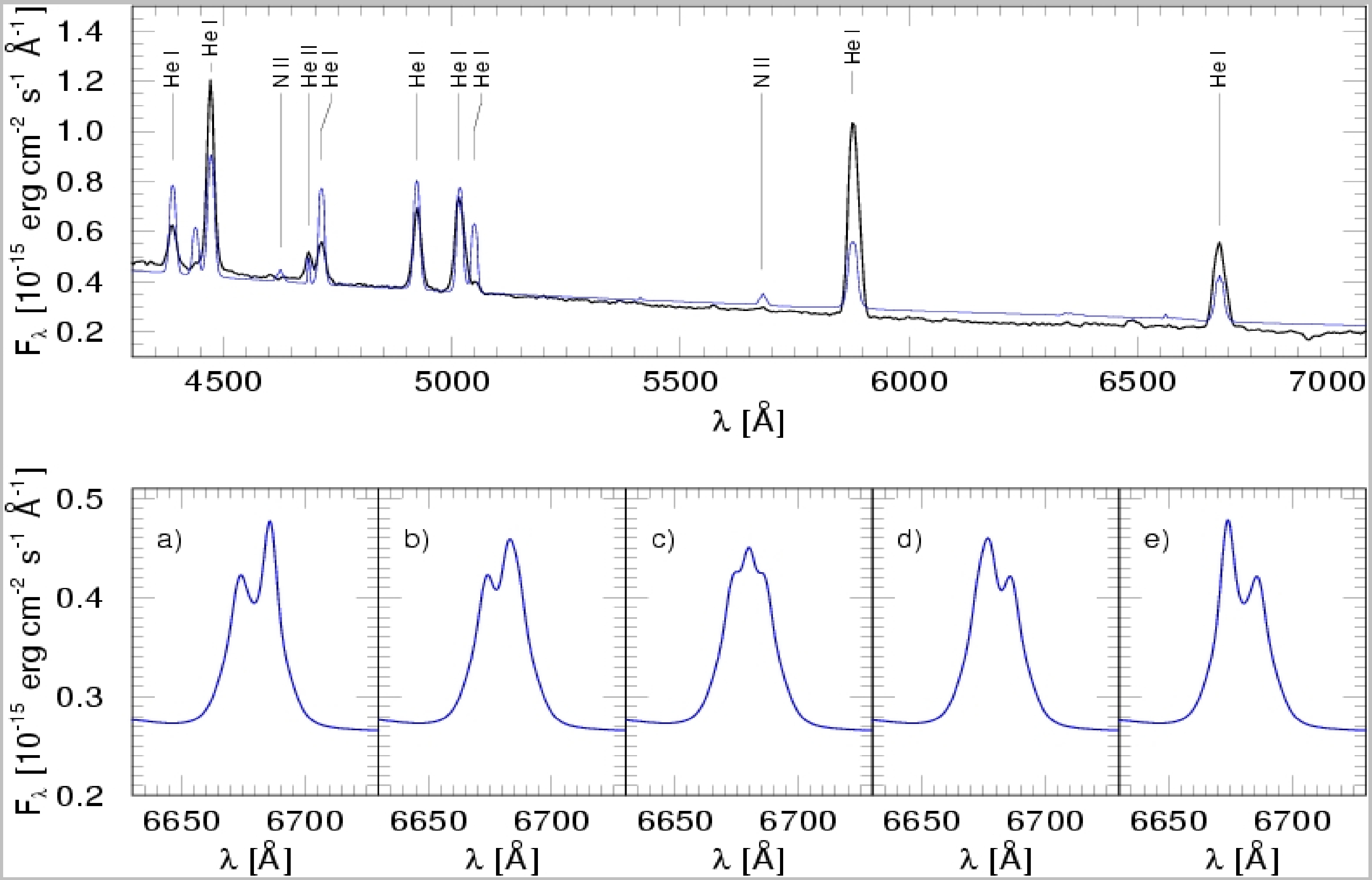
Models vs. Observation: CE 315



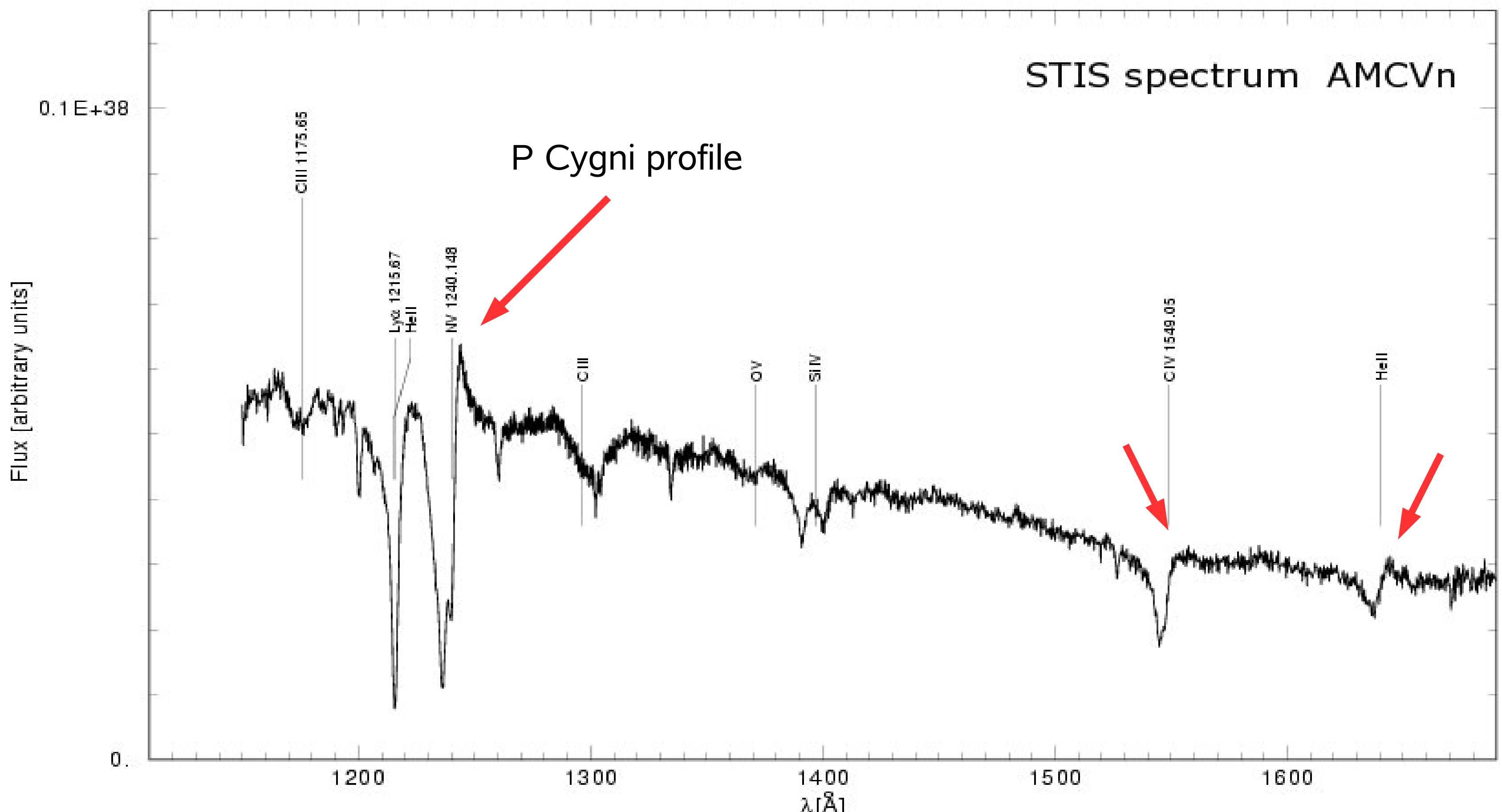
Models vs. Observation: CE 315



Models vs. Observation: CE 315



Accretion Disc Wind

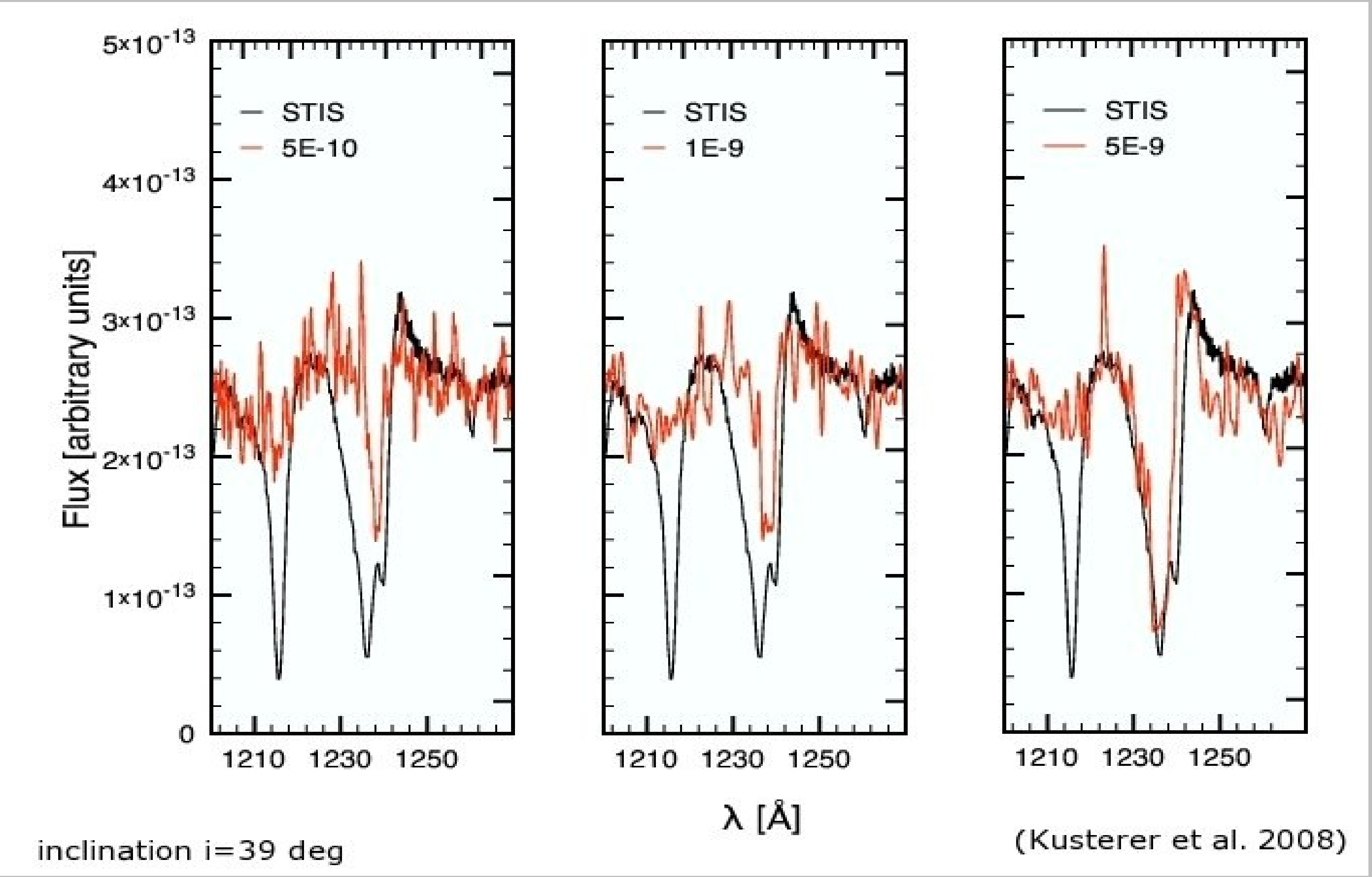


(Wade 2002)

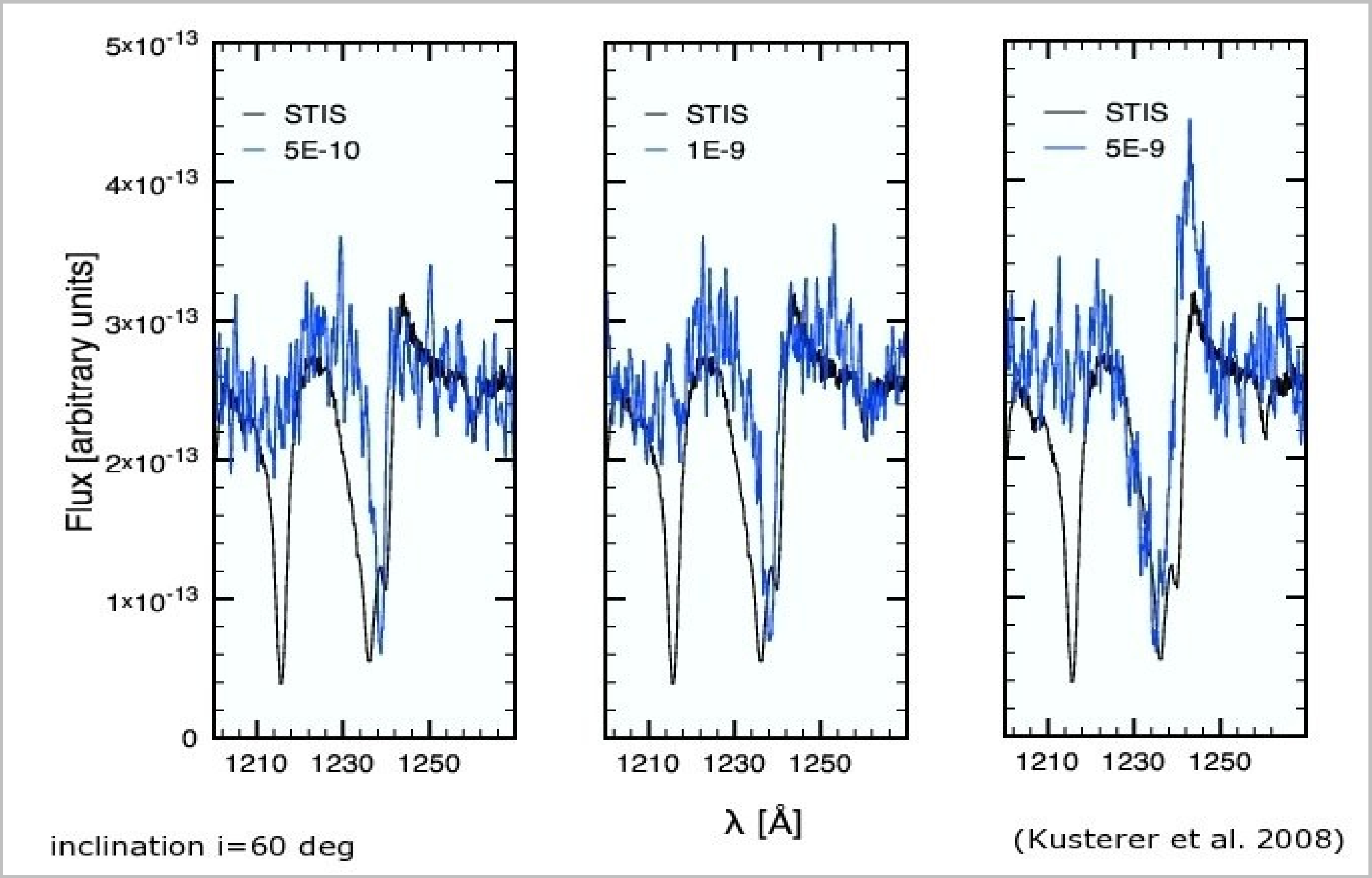
Accretion Disc Wind

- WOMPAT: Wind mOdel in Monte carlo Parallel rAdiative Transfer (D. Kusterer 2008, PhD Thesis)
- parallelized Monte Carlo code
- LTE occupation numbers
- iterative solution of temperature and ionisation structure
- calculated disc spectrum or blackbody as input

Accretion Disc Wind



Accretion Disc Wind



Summary

- grid of accretion disc models:
  - 0.6 - 1.4 $\mathrm{M}_{☺}$
  - 10^{-8} - 10^{-11} $\mathrm{M}_{☺}$/y
- reproduction of absorption and emission line spectra for high and low state
- irradiation by the primary seems to have almost no effect onto the spectrum

Summary

- spectroscopic detection of primary best possible in UV
- indication of underabundance of Si in CE315
  (also no Si found in X-ray [Ramsay et al. 2006] and UV [Gänsicke et al. 2003])
- Monte Carlo based accretion disc wind