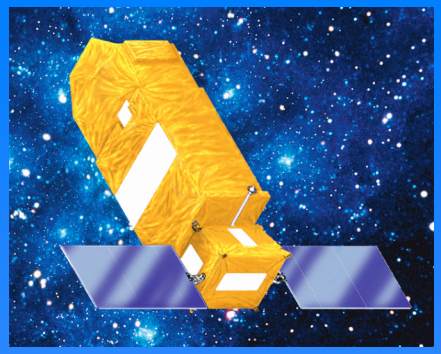
Recent Discoveries in the Far Ultraviolet



Hot Stars and Mass Loss

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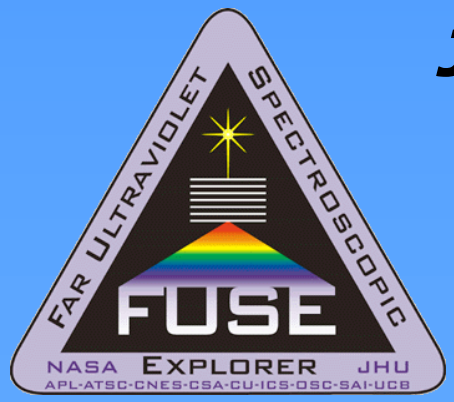


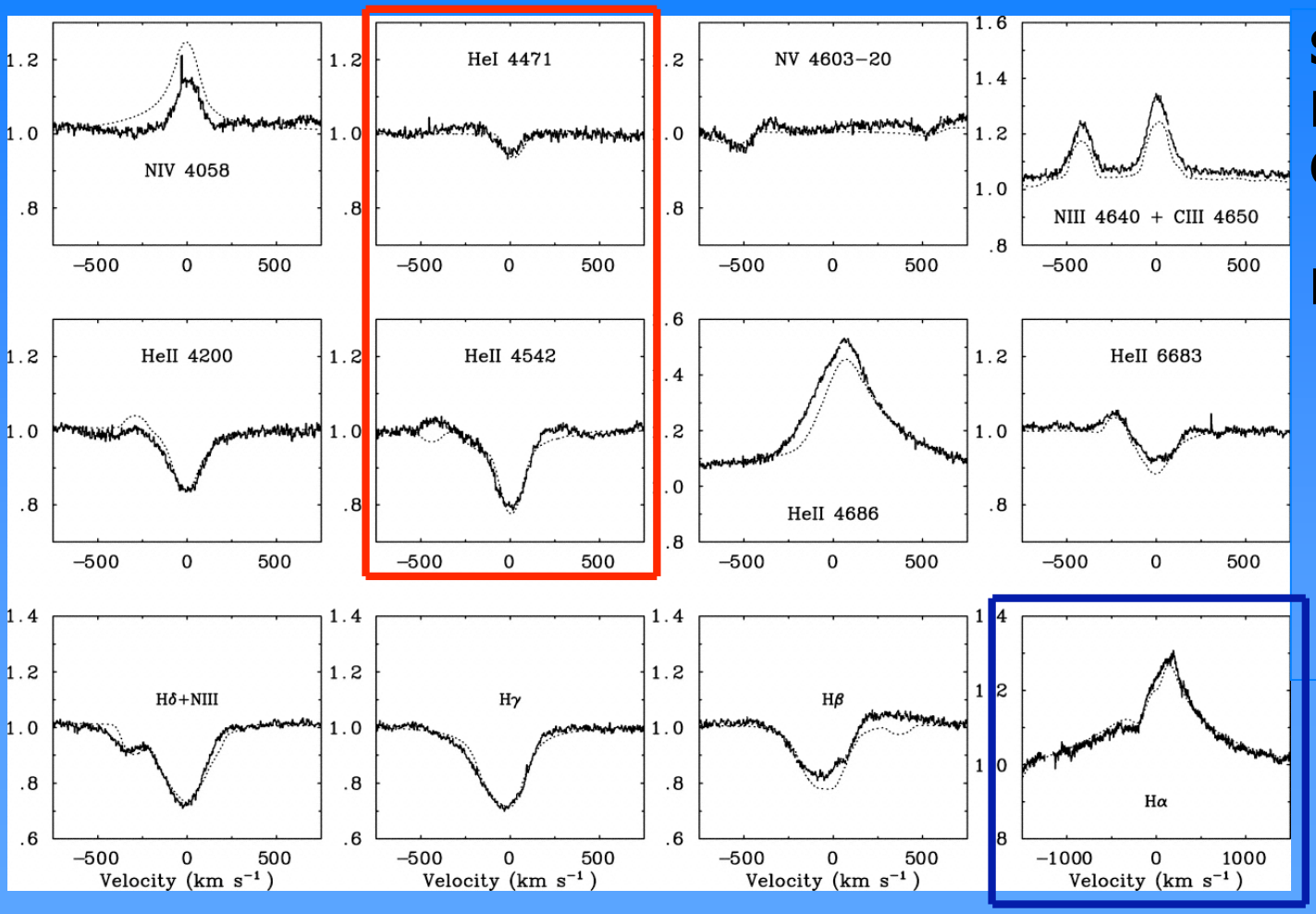
AAS 207th Meeting; 2006 January 12

Fundamental Questions

1. **How hot are O-type stars?**
   - FUV contributions to a revised T_{eff} scale.

2. **What are their mass-loss rates?**
   - FUV contributions to revised mass-loss rates.

Modeling Line Profiles to Determine T_{eff}

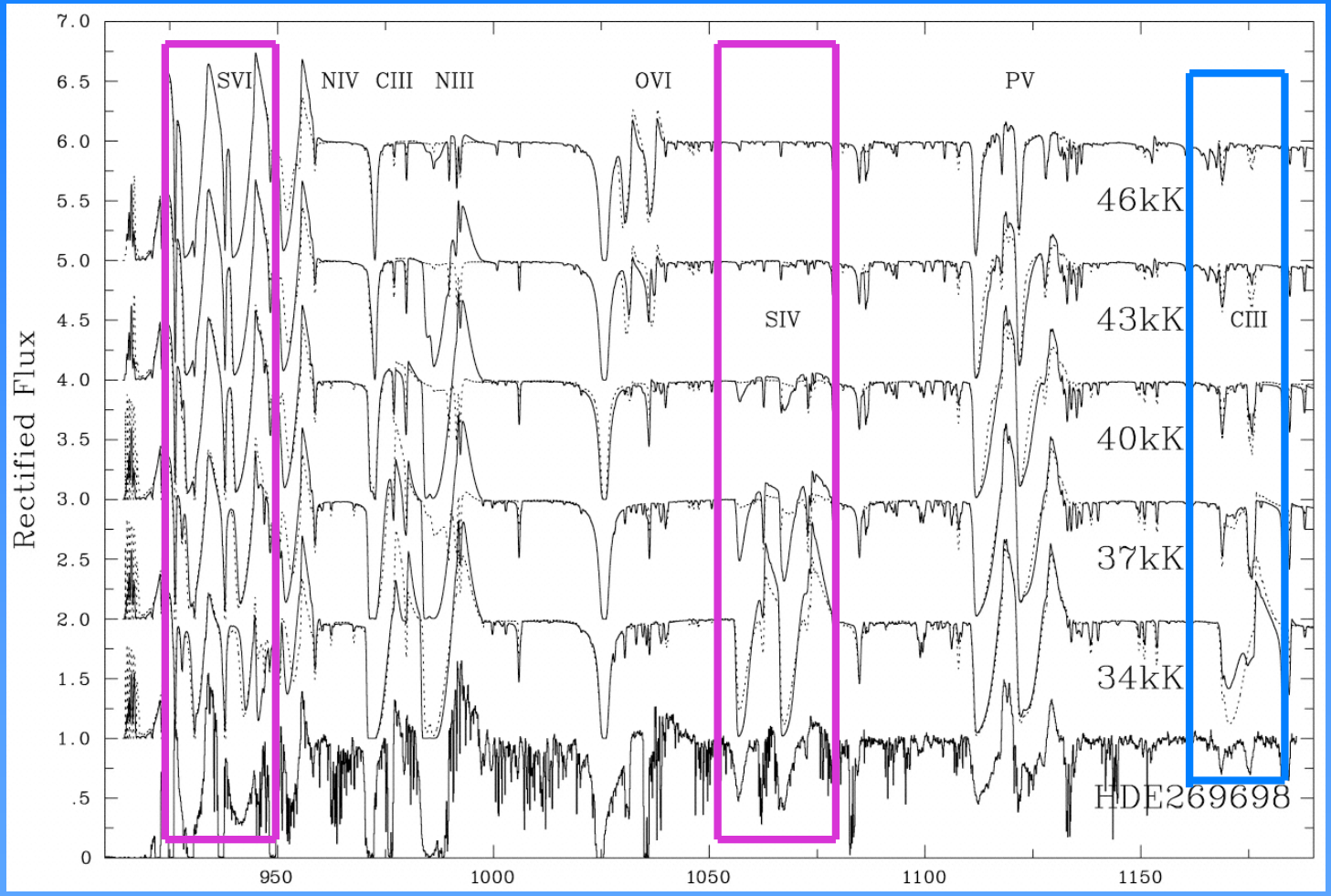


Sk –67°166
HDE 269698
O4 If+

Fit for
T_{eff}
log g
dM/dt
abundances
v sin i
[v_∞]

Crowther et al. 2002, ApJ, 579, 774

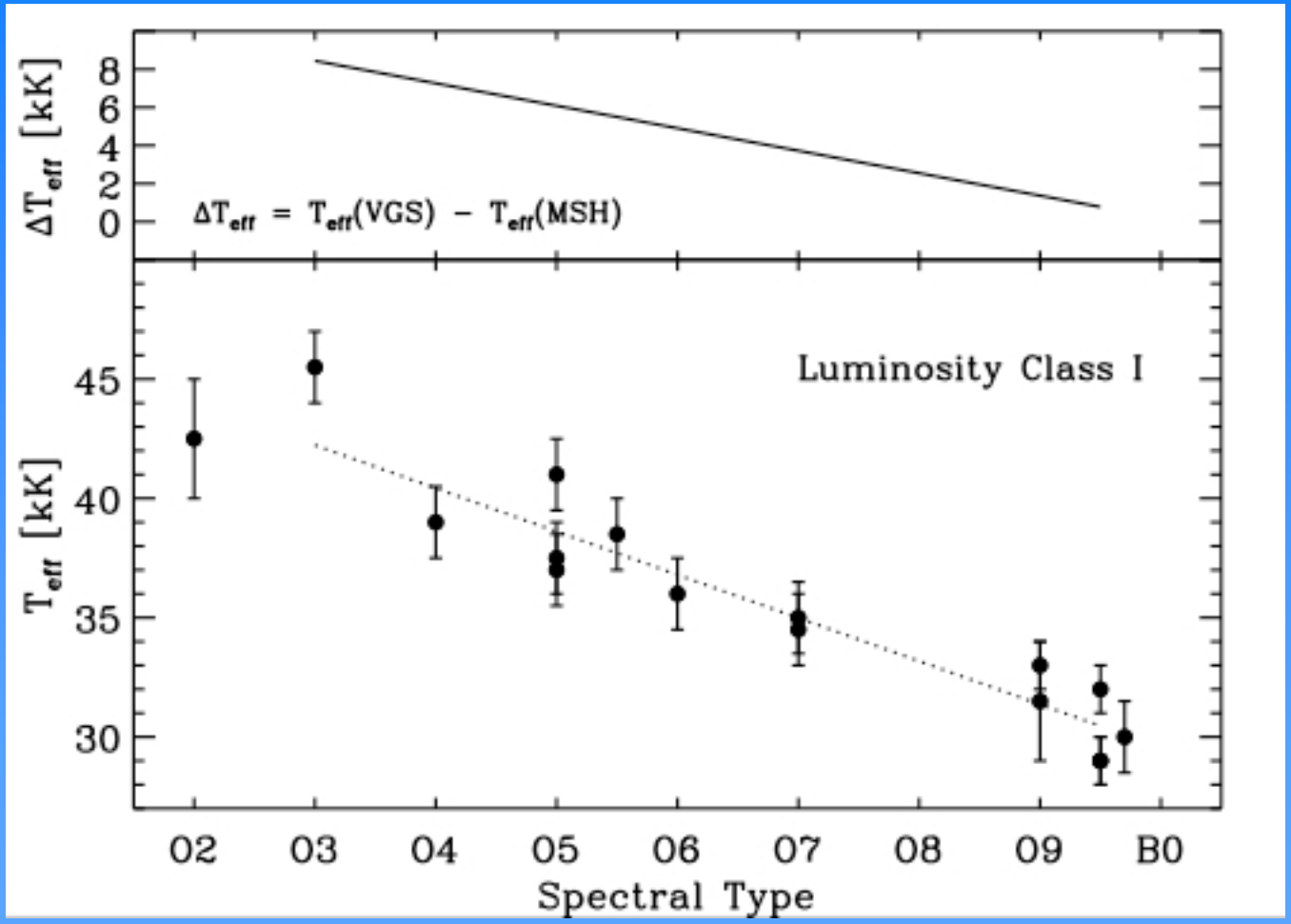
FUV/UV Spectra Are Sensitive to T_{eff}



Crowther et al. 2002, ApJ, 579, 774

New!

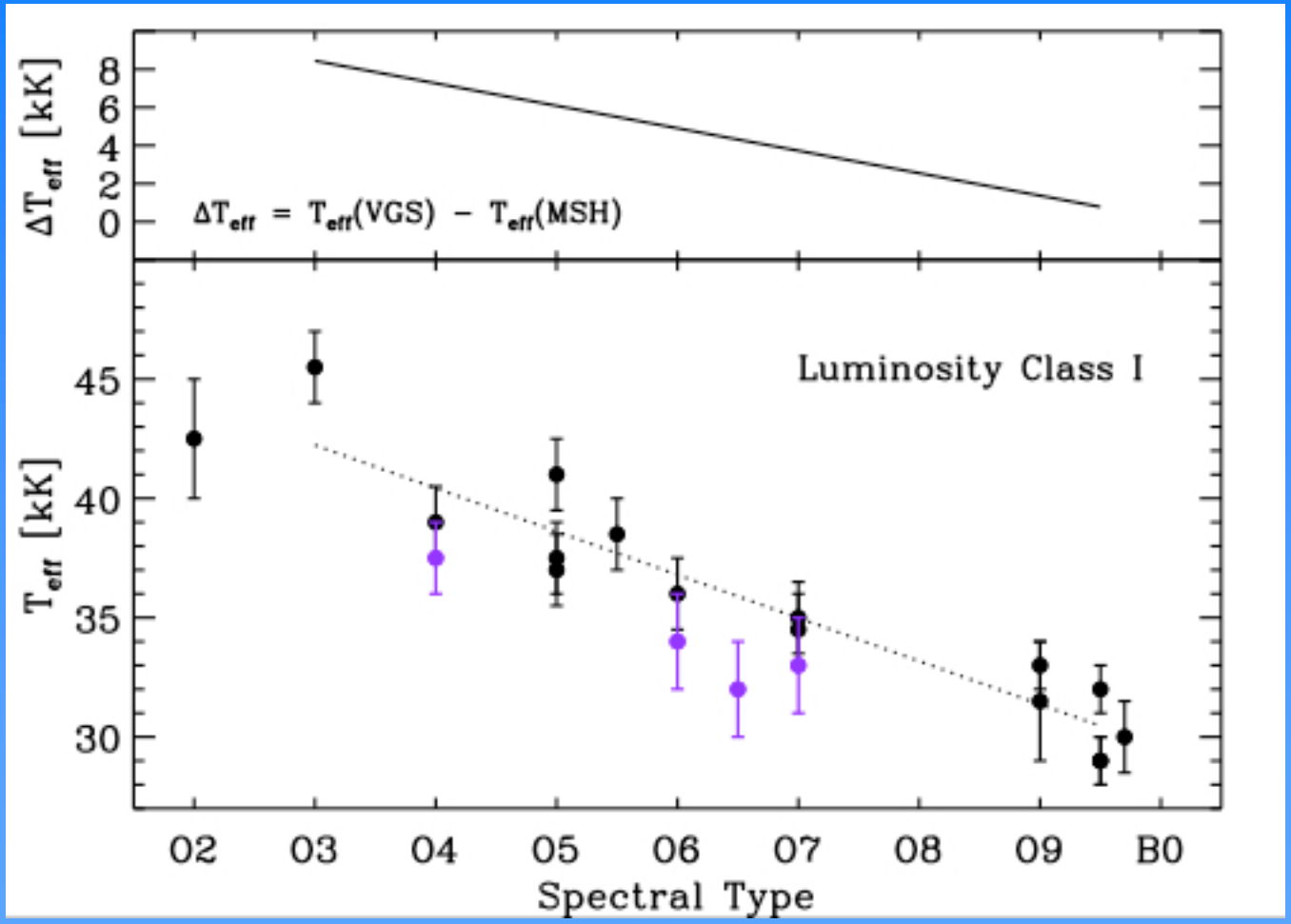
Revised T_{eff} Scale for O Stars



Adapted from Martins, Schaerer, & Hillier 2005, A&A, 436, 1049

New!

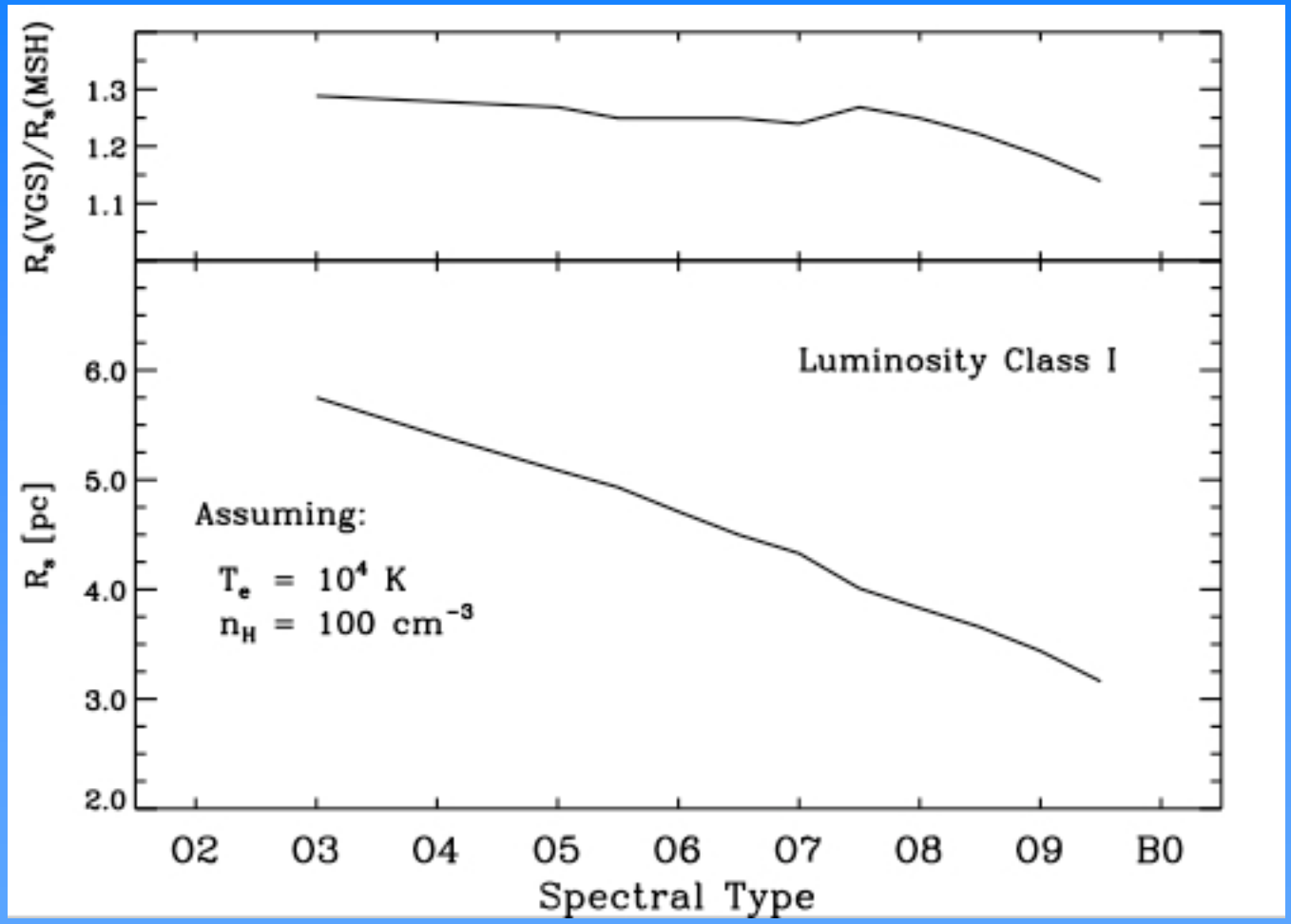
Revised T_{eff} Scale for O Stars



Adapted from Martins, Schaerer, & Hillier 2005, A&A, 436, 1049

New!

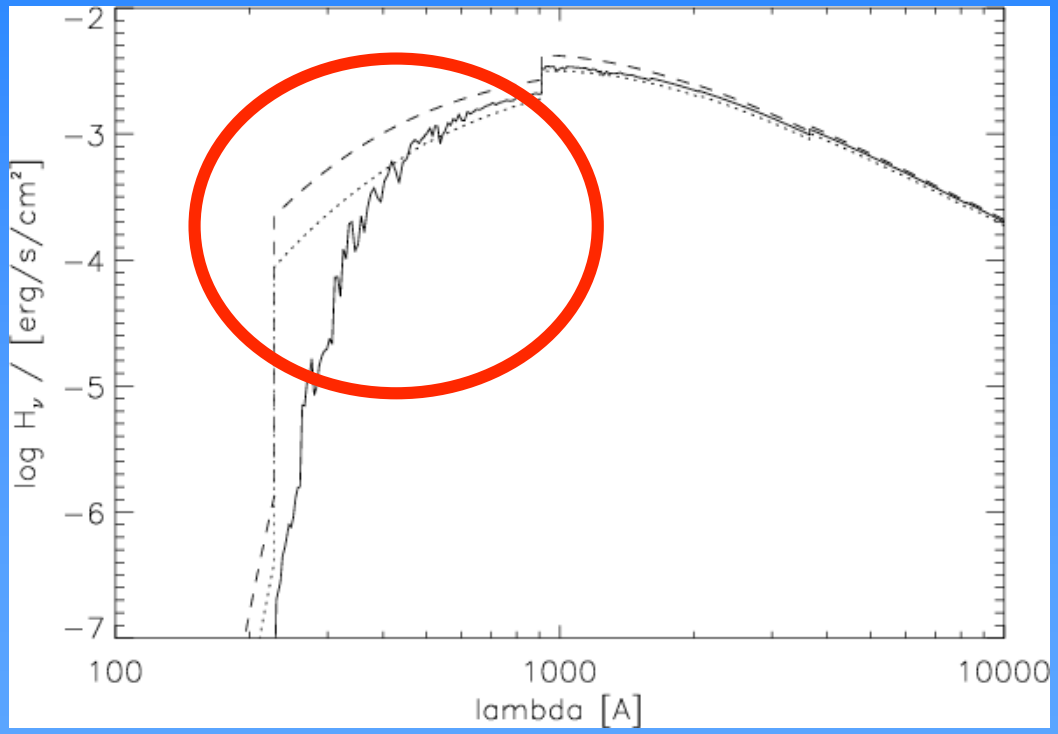
Radii of Strömgren Spheres



Adapted from Martins, Schaerer, & Hillier 2005, A&A, 436, 1049

What Changed?

Metallic line blanketing is now included in non-LTE models of Expanding atmospheres. Backwarming means that a cooler T_{eff} will reproduce the same line ratios (e.g., He I / He II).



	T_{eff} [kK]	log g
———	40.5	3.7
·····	40.5	3.7
– – –	45.0	3.9

Repolust, Puls, & Herrero 2004, A&A, 415, 349

Mass-Loss Diagnostics

Thermal radio emission:	free-free	$\propto \rho^2$
Hα emission:	recombination	$\propto \rho^2$
UV resonance lines:	scattering	$\propto \rho$

Mass-Loss Diagnostics

$$\dot{M} q_i(w) = \left(\frac{mc}{\pi e^2}\right)\left(\frac{4\pi\mu m_H}{f\ \lambda_0\ A_E}\right) R_\star\ v_\infty^2\ x^2\ w\ \frac{\mathrm{d}w}{\mathrm{d}x}\ \tau_{rad}(w)$$

UV resonance lines: scattering $\propto \rho$

Mass-Loss Diagnostics

$$\dot{M} q_i(w) = \left(\frac{mc}{\pi e^2}\right)\left(\frac{4\pi\mu m_H}{f\ \lambda_0\ A_E}\right) R_\star\ v_\infty^2\ x^2\ w\ \frac{\mathrm{d}w}{\mathrm{d}x}\ \tau_{rad}(w)$$

UV resonance lines: scattering $\propto \rho$

Constants, Parameters

Velocity Law

Optical Depth

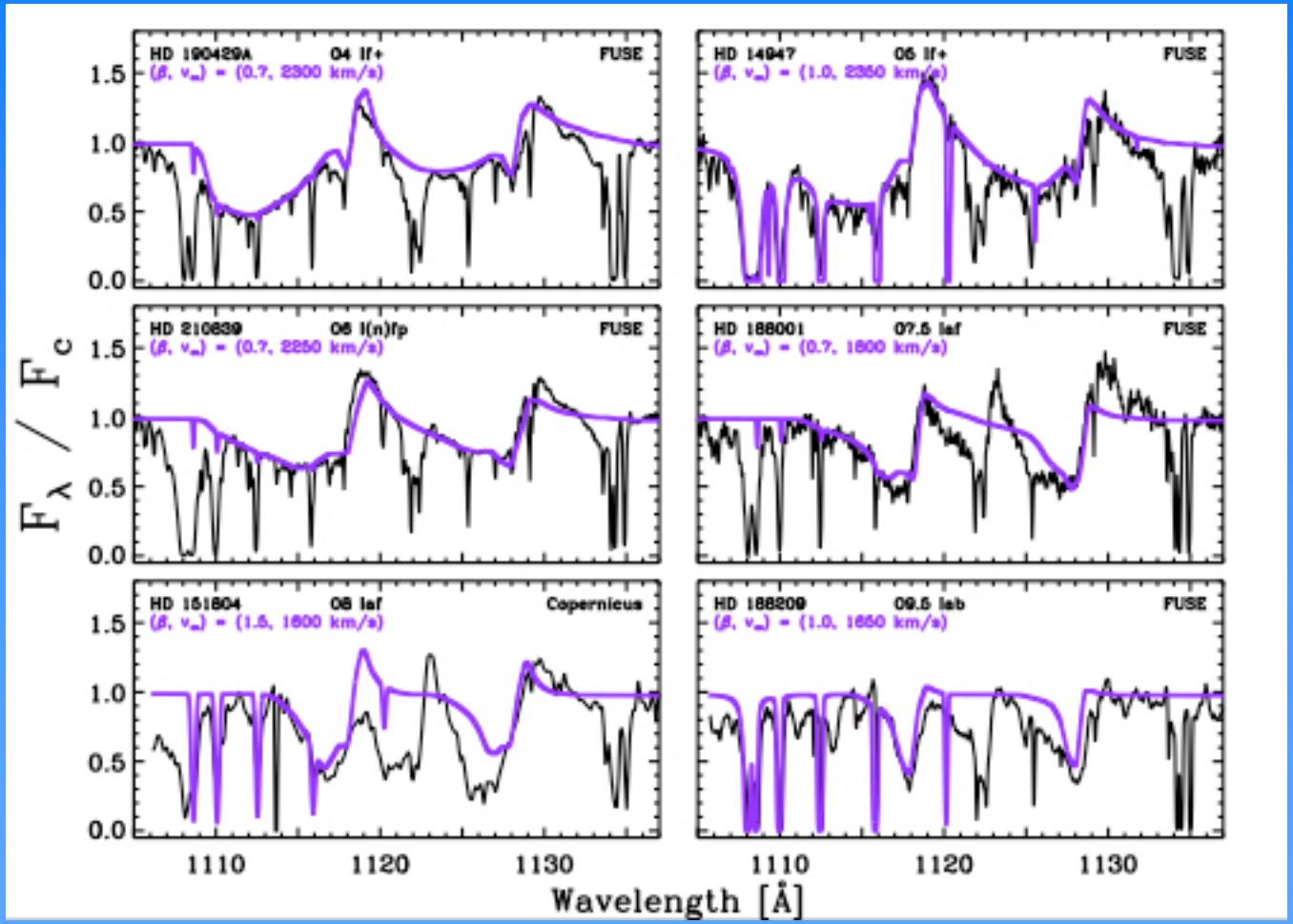
Ionization Fraction: $0 \le q_i \le 1$
Usually Don't Know
Usually Can't Estimate

Wind Profile Fits to P V λλ1118, 1128

O4

O6

O8



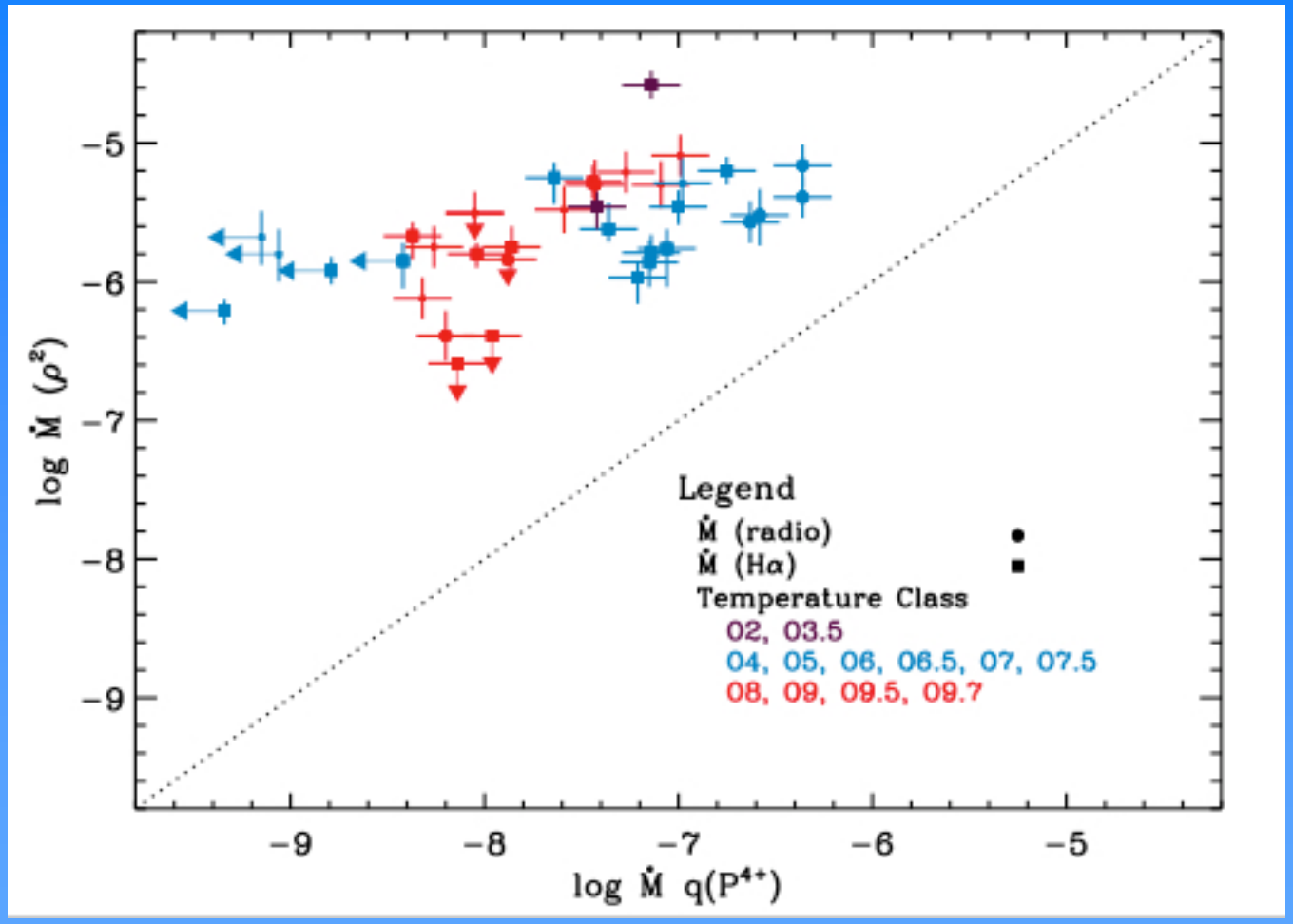
O5

O7.5

O9.5

Fullerton, Massa, & Prinja 2006, ApJ, 638, in press

A Mass Loss Discrepancy



Fullerton, Massa, & Prinja 2006, ApJ, 638, in press

Resolution:

O-star winds are clumped.

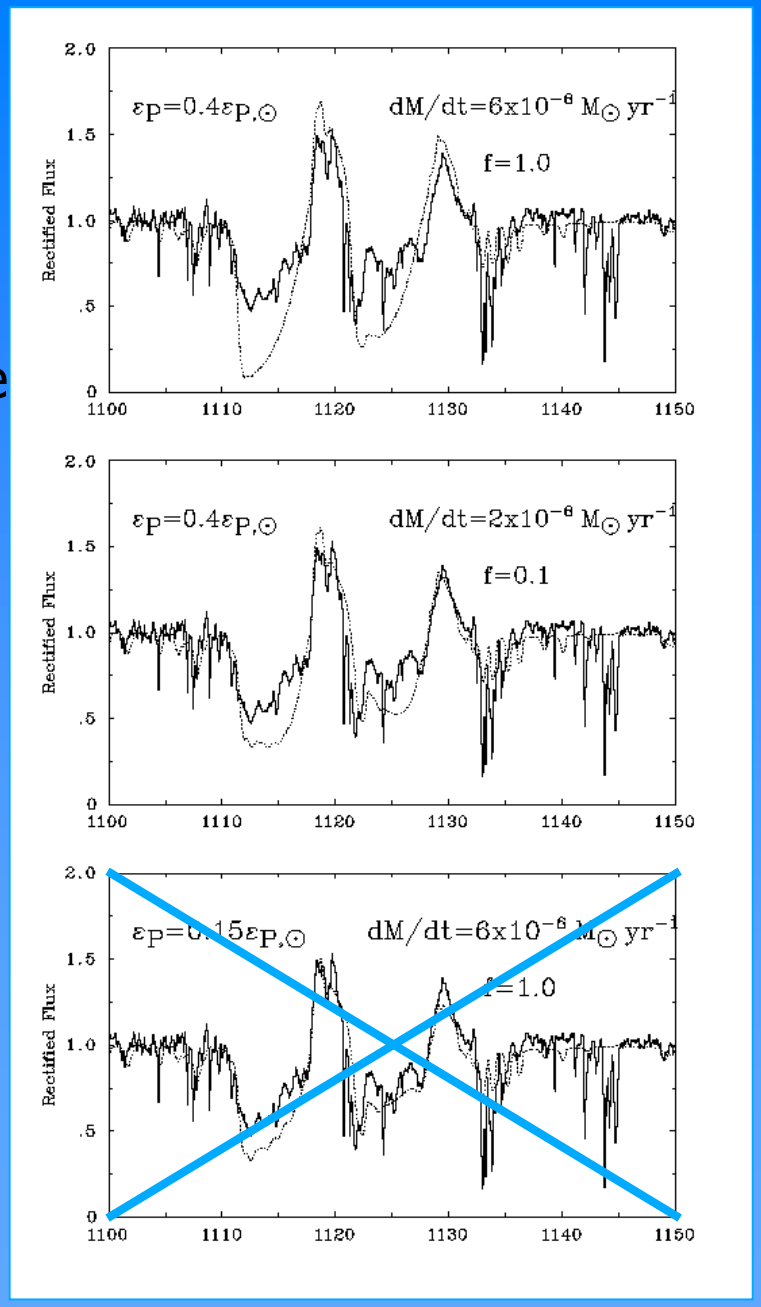
"ρ^2" diagnostics systematically over-estimate dM/dt.

Modest effect on measurements of UV resonance lines; but complicates expected behavior of q.

TODAY! See Poster 182.23 by Bouret, Lanz, & Hillier.

Sk –67°166 = HDE 269698 [O4 If+]

Crowther et al. 2002, ApJ, 579, 774



Summary:
Hot Stars and Mass Loss

Modern O-Type Stars Are:

- **2–20% cooler than they used to be**
  - 50–125% fewer Lyman continuum photons
  - Strömgren spheres 10–30% smaller

- **losing 3–10 (or more?) times less mass**
  - less material, inhomogeneously distributed

Other FUSE Hot-Star Highlights

- **Detection of a hot companion to Eta Car by Iping et al. TODAY! Posters 175.06 & 175.11.**
- **Systematic studies of wind-wind collisions in O-type binaries (St-Louis et al.).**
- **Pulsational variations of the Beta Cephei variable BW Vul (Smith et al.).**
- **Production of 3 detailed FUV atlases:**
  - **Magellanic OB Stars (Walborn et al.)**
  - **Galactic OB Stars (Pellerin et al.)**
  - **Galactic & Magellanic W-R Stars (Willis et al.)**

With still more to come….