Table 6. Input parameters for example physical model of 177-341

Stellar spectrum:	$T_* = 39\,000$ K
(Simón-Díaz et al. 2006)	$\log g = 4.1$
	$L_* = 2.04 \times 10^5\, L_\odot$
Ionizing flux at proplyd:	$\Phi_\mathrm{H} = 1.58 \times 10^{13}\ \mathrm{cm^{-2}\ s^{-1}}$
Ionization front radius:	$r_0 = 1.91 \times 10^{15}$ cm
Gas-phase abundances:	He 10.98, C 8.41, N 7.89, O 8.50,
	Ne 7.78, S 7.04, Ar 6.33, Fe 5.77
Dust composition:	Standard Orion (Baldwin et al. 1991)

6.3 A physical model of 177-341

As an alternative to the purely empirical analysis presented in the previous sections, a different approach to analysing the emission spectrum of the proplyds is through the construction of physical models that combine a priori simulations of radiative transfer, hydrodynamics, and atomic physics in order to predict the density, temperature, and ionization structure of the proplyd flow. Such models have previously been applied to the ensemble properties of large numbers of proplyds (Johnstone, Hollenbach, & Bally 1998; Henney & Arthur 1998) and in detail to individual objects such as 177-341 (Henney & O'Dell 1999), LV2 (Henney et al. 2002), and LV1 (Graham et al. 2002). We have improved on these models in two significant ways. First, whereas published models have considered only emission from regions where hydrogen is fully ionized and the flow is supersonic, we now use a detailed analytic model of gas acceleration in the ionization front (Henney et al. 2005) to extend the treatment to cover partially ionized emission zones where the gas moves subsonically. Second, whereas published models used ad hoc fitting functions to the emissivity structure, specifically tailored to only the brightest emission lines, we now use the plasma micropysics code Cloudy (Ferland et al. 1998) to self-consistently calculate the full physical structure and emission spectrum of the proplyd flow.

Preliminary results of the emission line spectrum of such a model applied to 177-341 are shown in Figures 10 and 11. The input parameters for the model (values given in Table 6) are the radius of the ionization front at the proplyd cusp (assumed hemispherical), the intensity and spectral shape of the illuminating stellar radiation, and the composition (gas-phase elemental mix and dust grain populations) of the proplyd material. For most of these parameters, we have taken values from the literature, whereas the gas-phase abundances and incident ionizing flux have been adjusted slightly in an attempt to reproduce the observed emission line intensities. The stellar spectrum is that determined for the ionizing star θ^1 Ori C by spectroscopic analysis (Simón-Díaz et al. 2006). The ionization front radius is the value determined by fitting to *HST* emission line images (Henney & O'Dell 1999), while the adopted ionizing flux at the proplyd position corresponds to a physical separation of the proplyd from the ionizing star of 2.13×10^{17} cm if there is no intervening absorption. Given the observed angular separation of $25.84''$ (Bally et al. 1998), and assuming a distance to the Orion Nebula of 440 pc (O'Dell & Henney 2008, Appendix A), the projected separation is 1.70×10^{17} cm, implying an inclination angle of $\simeq 55°$. The diffuse radiation field and the proplyd tail are ignored in this model, since the observational aperture (§ 2.2) only covers the head of the proplyd.

Figure 11 shows that the model generally reproduces very well the observed relative line intensities for 177-341.

STILL TODO

- **Replace figures with model with lower O abundance**
- **Discuss failure to reproduce [O I] – possible dissociation component that is not include in model**
- **Discuss marginal problem with [S III] – details of stellar atmosphere spectrum, WMBasic vs Tlusty**
- **Discuss Figure 10 vs Figure 7a. Fact that the intersection of the three curves in Figure 7 is not the correct solution (according to our model) since the three ions [O III], [N II], and [S II] come from different regions with different n_e, T_e.**
- **Discuss fact that model is only representative and abundance values are not necessarily reliable (especially where only one ion stage is observed)**
  - **should take into account aperture more carefully**
  - **need to investigate effects of varying dust properties**
  - **internal extinction within the proplyd flow**
  - **need to constrain with additional existing observations (HST imaging; velocity profiles; mid-IR emission)**

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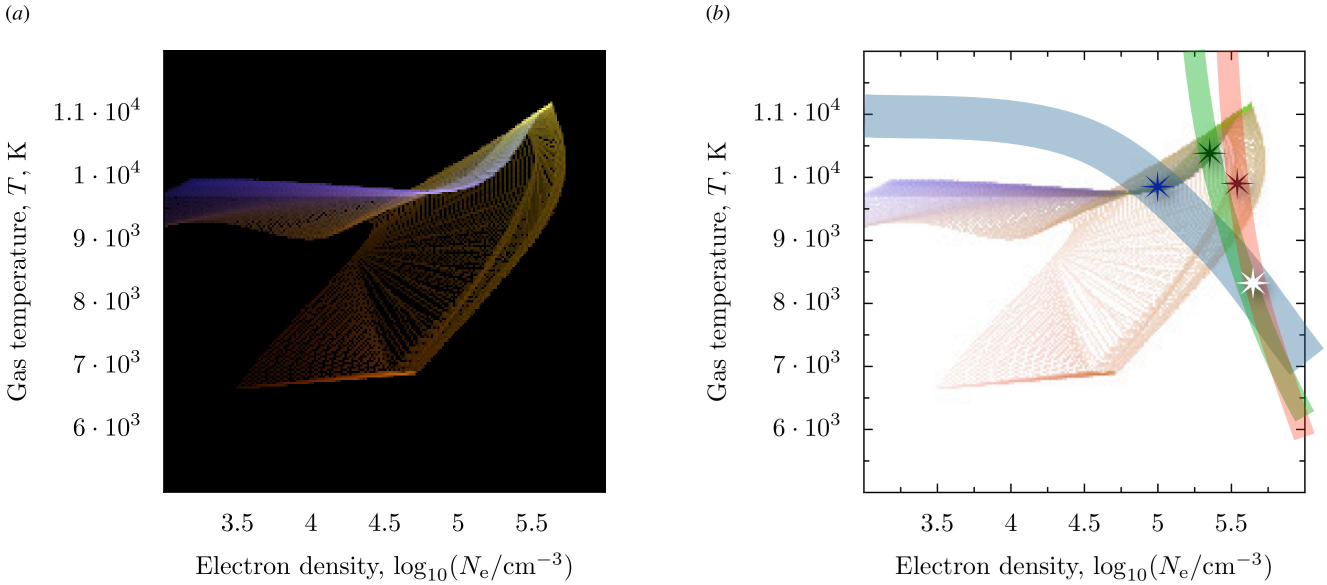

Figure 10. Emission structure in the n_e–T_e plane for the example physical model of 177-341. (*a*) Positive-colored image of the three emission lines: [S II] 6731 Å (red), [N II] 6584 Å (green), and [O III] 5007 Å (blue), with brightness proportional to the fraction of the model luminosity in each line that comes from gas with that particular combination of density and temperature. The variations in density and temperature within the model are principally a function of radius within the proplyd, with a secondary variation as a function of angle between the "nose" and the "ears" of the proplyd crescent. The outer zones of the model are at low density and are highly ionized, emitting principally in [O III], as seen in the blue horizontal branch at ≃ 9700 K in the upper left part of the figure. As one approaches the proplyd ionization front (direction of increasing density), the [N II] and then [S II] emission become relatively stronger (color changes to yellow) and the temperature increases, reaching a maximum of ≃ 11 000 K. In the ionization front itself, the temperature drops while the electron density climbs to a peak of about 3×10^5 cm^{-3} and then also falls. At the same time, the [S II] emission comes to dominate over [N II], giving rise to the orange-red that curves down and to the left. (*b*) Negative-colored image of the same data as in *a* overlayed with the observational diagnostic curves from Fig. 7*a*. The white star shows the solution for n_e, T_e obtained in § XX under the assumption that the emission in all three ions is co-extensive at a single density and temperature.

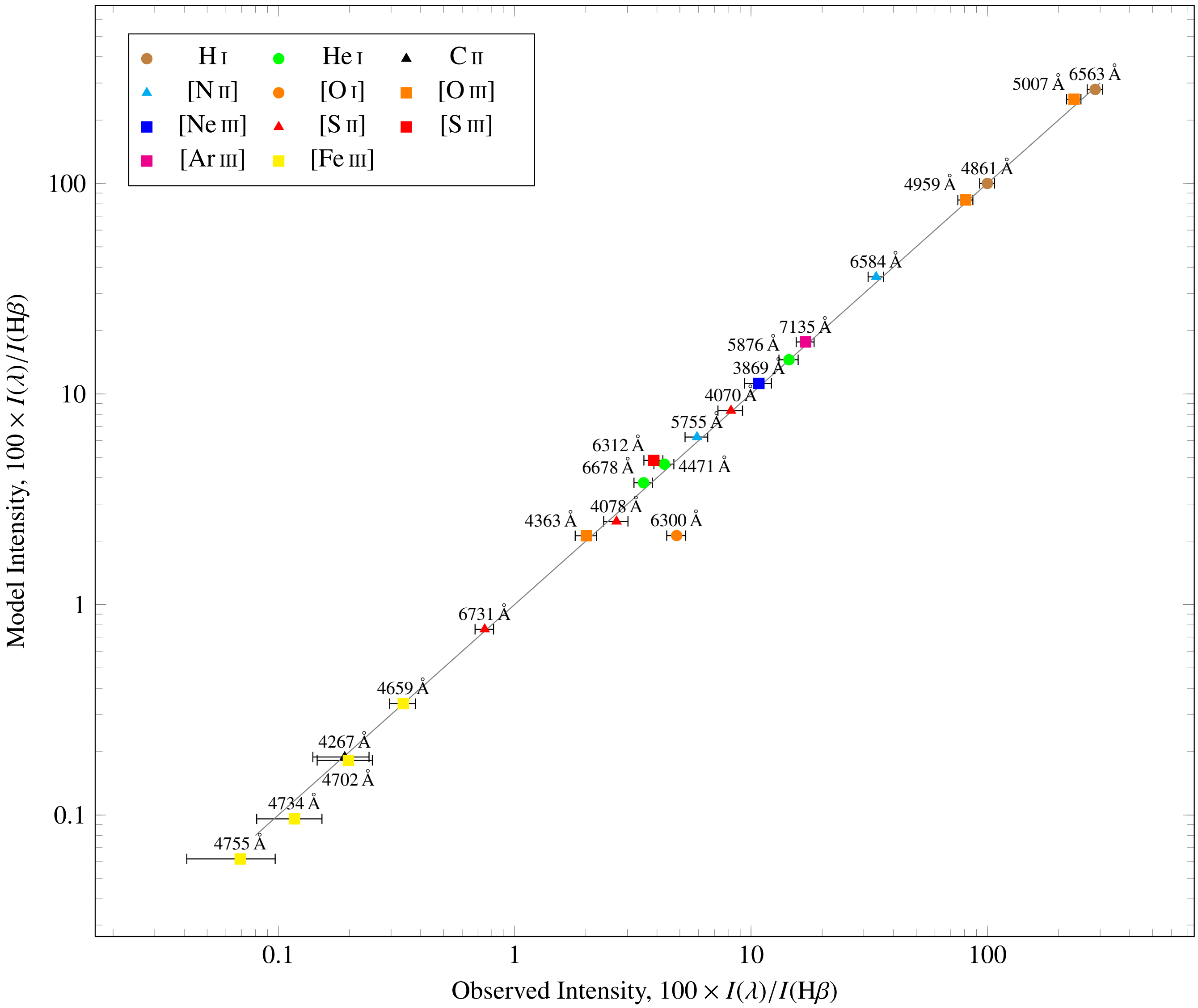

Figure 11. Comparison of model and observed line intensities for 177-341.