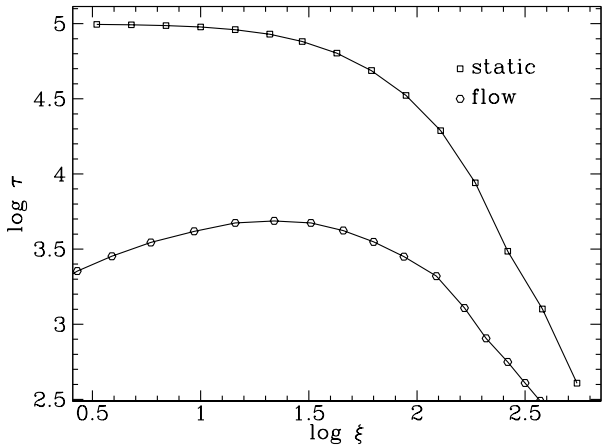

Fig. 2. Optical depth (τ) static case vs outflow model for the line Ne X λ12.134 (see text).

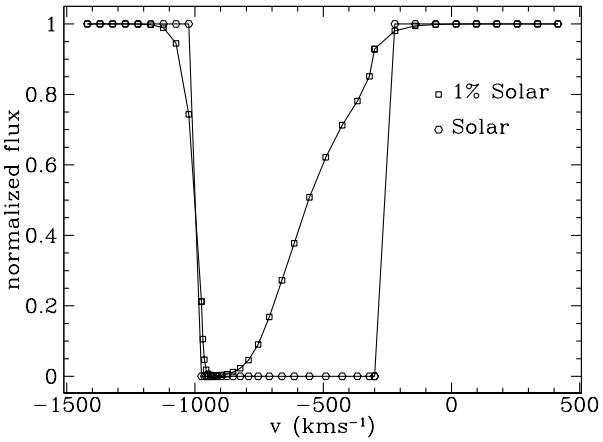

Fig. 3. Profile of the line Ne X λ12.134 formed by taking $F_\lambda(v) = F_c \times \exp[-\tau_\lambda(v)]$ as function of the velocity. The rectangle profile is made by a cloud with solar abundances (open circles). The profile with an extended red wing and a sharp blue wing is made by a cloud with 1% solar abundances (open square).

1000 km s^{-1}. In both cases we adopt a turbulence velocity of 200 km s^{-1} and solar abundances. In the stationary case, τ is proportional the column density of the absorbing material and can reach very large values. In the outflow model, τ peaks at $\log \xi \sim 1.3$ ($v \sim 890$ km s^{-1}) reaching $\sim$5000, that is, nearly two orders of magnitude smaller than in the stationary cloud for the same ξ. Such high optical depths are common to other lines in the X-ray band, like O VIII in the 14–20 Å and the line O VIII λ18.969. In such cases lines appear saturated in the absorption spectrum in contrast with observation. In Ramírez et al. (2005) we fitted the integrated optical depths of resonant lines in the spectrum of NGC 3783 and found $T_{\rm tot} \lesssim 1$ for most of the lines. We illustrate in Figure 3 the consequences of taking this model for the reproduction of the profile of the line Ne X λ12.134. In order to have a non-saturated line (as observed), we had to reduce the abundance to $\sim$1% solar, which has no physical motivation. We do not go further with this model, and present the clumpy (multicomponent) scenario in the next section.

3.2. *The Multicomponent Model*

Now, we examine the scenario in which the absorption profile seen in the X-ray and UV spectra of AGNs are made up of multiple components. The main difference between this model calculations and previous ones by other authors (e.g., Kaspi et al. 2002; Krongold et al. 2003; Różańska et al. 2006), is that in our model all the components are linked by a velocity law and a gas density distribution.

Each absorber is specified by an ionization parameter ξ, a column density N_H, an absorption covering factor, a gas density $n_H(r)$ and an outflow velocity $v(r)$ in order to shift the absorption lines according to the Doppler effect. Once the ionic fraction is calculated from the ionization equations, and the ionic levels computed, the opacity in each frequency bin is

$$\kappa_\nu \rho = \frac{\pi e^2}{m_e c} f_l n_l \left[1 - \frac{n_u g_l}{n_l g_u}\right] \phi(\Delta\nu), \qquad (9)$$

where κ_ν is the opacity at the frequency ν, $\rho = \mu m_H n_H$ is the mass density, f_l is the absorption oscillator strength, n_l, n_u (in cm^{-3}), g_l, g_u are the number density and the statistical weight of the lower and upper levels of the transition, respectively. We allow for the lines to have a finite width characterized by the line profile $\phi(\Delta\nu)$, with a width which is the greater one between the thermal and the turbulent motions. In all our models the turbulence velocity is assumed to be 200 km s^{-1}. The optical depth of a line in each component is

$$\tau_\nu = \int_{r_1}^{r_2} \kappa_\nu(r)\rho(r)dr, \qquad (10)$$

where r_2 and r_1 are the limits of the cloud.

It is important to highlight a special difference between the way we use the ionization parameter in the MC model and the way it is used in the SA model. Because the clouds intervening in this model are optically thin, the ionization parameter at the most exposed face of the cloud remains essentially constant through the cloud, i.e.

$$\xi(r) = \frac{4\pi F(r)}{n_H(r)}, \qquad (11)$$