# The Effect of Porosity on X-ray Emission Line Profiles from Hot-Star Winds

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We investigate the degree to which the nearly symmetric form of X-ray emission lines seen in {\it Chandra} spectra of early-type supergiant stars could be explained by a possibly porous nature of their spatially structured stellar winds. Such porosity could effectively reduce the bound-free absorption of X-rays emitted by embedded wind shocks, and thus allow a more similar transmission of red- vs. blue-shifted emission from the back vs. front hemispheres. To obtain the localized self-shielding that is central to this porosity effect, it is necessary that the individual clumps be optically thick. In a medium consisting of clumps of size $\ell$ and volume filling factor $f$, we argue that the general modification in effective opacity should scale approximately as $\kappa_{eff} \approx \kappa/(1+\tau_{c})$, where, for a given atomic opacity $\kappa$ and mean density $\rho$, the clump optical thickness scales as $\tau_c = \kappa \rho \ell/f$. For a simple wind structure parameterization in which the `porosity length' $h \equiv \ell/f$ increases with local radius $r$ as $h = h' r$, we find that a substantial reduction in wind absorption requires a quite large porosity scale factor, $h' > 1$, implying large porosity lengths $ h > r$. The associated wind structure must thus have either a relatively large scale $ \ell \approx r$, or a small volume filling factor $f \approx \ell/r \ll 1$, or some combination of these. We argue that the relatively small-scale, moderate compressions generated by intrinsic instabilities in line-driving are unlikely to give such large porosity lengths. This raises questions about whether porosity effects could play a significant role in explaining nearly symmetric X-ray line profiles, leaving again the prospect of instead having to invoke a substantial (ca.\ factor 5) downward revision in the assumed mass-loss rates.

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Weblink: http://www.bartol.udel.edu/~owocki/preprints/xporosity.pdf

Comments:

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