Variability in X-ray line ratios in helium-like ions of massive stars: the radiation-driven case

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Line ratios in "fir" triplets of helium-like ions have proven to be a powerful diagnostic of conditions in X-ray emitting gas surrounding massive stars. Recent observations indicate that these ratios can be variable with time.
The possible causes of variation in line ratios are limited: changes in the radiation field or changes in density, and changes in mass-loss or geometry. In this paper, we investigate the ability of changes in the radiation field to induce variability in the ratio R=f/i.
To isolate the radiative effect, we use a heuristic model of temperature and radius changes in variable stars in the B and O range with low-density, steady-state winds. We model the changes in emissivity of X-ray emitting gas close to the star due to differences in level-pumping from available UV photons at the location of the gas.
We find that under these conditions, variability in R is dominated by the stellar temperature. Although the relative amplitude of variability is roughly comparable for most lines at most temperatures, detectable variations are limited to a few lines for each spectral type. We predict that variable values in R due to stellar variability must follow predictable trends found in our simulations.
Our model uses radial pulsations as a mode of stellar variability that maximizes the amplitude of variation in R. This model is robust enough to show which ions will provide the best opportunity for observing variability in the f/i ratio at different stellar temperatures, and the correlation of that variability with other observable parameters. In real systems, the effects would be more complex than in our model, with differences in phase and suppressed amplitude in the presence of non-radial pulsations. This suggests that changes in R across many lines concurrently are not likely to be produced by a variable radiation field.

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