Exploring the gas constituents in debris disks with high resolution UV spectroscopy

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We can learn about the composition, the structure and the physical state of the gas in a debris disk from the observations of UV atomic absorption features in the UV spectrum of a hot star when the disk is oriented nearly edge-on to our line of sight. This will be illustrated by our analysis of 304 absorption features from 25 different species in a total of 108 energy levels in the UV and visible spectra of 51 Oph, a Herbig B9.5 star with an estimated age of 1.2 Myr. We interpret the relative populations of atoms in excited fine-structure and metastable levels in terms of optical pumping and collisional interactions by electrons in the disk. In the case of 51 Oph we conclude that most of the gas that we can detect is situated at about 6 AU from the star, with an electron density of [10^5 – 3 10^6] cm^{-3} and a temperature T = 8000 K. The gas has N(H I) = 10^{21} cm^{-2}, it is partly ionized and, except for a deficiency of carbon, has an element composition similar to that of a mildly depleted ISM or the solid material within Jupiter-class comets.
We will also show the case of the star HD 42111, whose UV spectrum exhibits slightly asymmetric features with narrow cores and broad wings, suggestive of an accretion flow very close to the star as it wraps around the stellar disk. Modeling these features is work in progress.