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The Mass and Composition of the LkCa 15 disk

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The total disk gas mass and elemental C, N, O composition of a protoplanetary disk are crucial ingredients for our understanding of planet formation. Measuring the gas mass is complicated as we lack the far-IR facilities necessary to observe HD, and the elemental abundances with respect to hydrogen are degenerate with gas mass in all disk models. We determined the gas mass and elemental abundances of C/H and O/H in the transition disk around LkCa 15, one of the few disks for which HD data are available, combining as many chemical tracers as possible. Using a grid of 60 azimuthally symmetric thermo-chemical Dust And LInes models, we translate the observed fluxes to elemental abundances and constrain the best fitting parameter space. The molecules that constrain the gas mass and carbon abundance the most are C(17)O, N2H+ and HD, but all other molecules are consistent with these values. We find that the gas mass of LkCa 15 is an order of magnitude lower than previously assumed. The C/O ratio is found to be close to unity, which is consistent with literature values of water depletion in the disk. The low level of carbon depletion in LkCa 15 is consistent with the young age of the disk, but contrasts with the higher depletions seen in older cold transition disks. This contrast suggests that long carbon depletion timescales contribute to the evolutionary trend seen in the level of carbon depletion among disk populations, rather than evolving temperature effects and presence of dust traps alone.

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