Z203a Nitrogen Fractionation in the Protoplanetary Disk around TW Hya

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ALMA observations toward the protoplanetary disk around TW Hya show a nitrogen fractionation of HCN, and the $HC^{14}N/HC^{15}N$ ratio increases from ∼120 up to ∼330 as the distance from the central star increases from 20 AU to 50 AU. We investigate what physical and chemical conditions control the nitrogen fractionation. We developed a new disk model, which includes the isotope-selective photodissociation of molecular nitrogen and isotope-exchange chemical reactions. Our model reproduces the observed HCN column density when the gas phase carbon and oxygen elemental abundance are depleted by two orders of magnitude relative to those in the interstellar medium and carbon is more abundant than oxygen. The isotope-selective photodissociation of N_2 is a dominant nitrogen fractionation process in our models. We can reproduce the observed profile of $HC^{14}N/HC^{15}N$ ratio, which increases outwards, when the small dust grains in the outer disk atmosphere are more depleted than those in the inner disk atmosphere. This is consistent with the grain evolution models that the small dust grains are continuously replenished in the inner disk due to fragmentation of the large dust grains which are radially drift from the outer disk. Our model predicts that the HCN 1-0 line, observable by ngVLA, could be optically thinner and then be a better tracer of nitrogen fractionation than the HCN 4-3 line, observed by ALMA, especially near the central star (< 20 AU) where planets form.