Modeling Chemistry in the Accretion Disk of an Active Galactic Nucleus

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Understanding the processes of galaxy formation, mass accretion onto a supermassive black hole and its connection to star formation are of great interest in astrophysics. It is useful to know the condition of the interstellar medium in different types of galaxies such as ultra-luminous infrared galaxies (ULIRGs), active galactic nuclei (AGN), and starburst galaxies. Some molecules have been proposed as probes of AGN/starburst activity in galaxies. For example, Kohno [1] found that a higher HCO^+/HCN intensity ratio is favored in starburst galaxies than in AGN-dominant galaxies. Enhanced HCN and CN intensity and abundances are observed in AGN-dominant galaxies. A higher HCN abundance and some complex molecules are observed in ULIRGs [2][3].

We model the chemistry in the molecular disk around an AGN using the condition of NGC 1068. We include the ionization by X-rays from the AGN core, cosmic-rays from the supernovae and stellar winds. The effect of UV-photons is also discussed. We used the OSU high temperature chemical network [4]. X-ray penetration is dependent on the disk structure, and we tried to vary this structure. In most cases, the effect of X-rays at radii >10pc can produce slightly less than the observed abundance of CN over the total hydrogen, which is (0.2-1) $x10^{-7}$ at the 70 pc scale[5]. The HCN abundance is enhanced with high temperature in the inner disk, and our results produce equal to or more than the value suggested by Usero et al., which is (0.8-1) $x10^{-7}$[6]. If there is a dense midplane that X-rays cannot penetrate into, complex molecules such as C_2H_2 and HC_3N, are enhanced at the very inner part of the AGN-disk due to the high temperature. The advent of ALMA will resolve some of these molecules in higher resolution and may provide useful information on the disk structure and the star-formation activities.

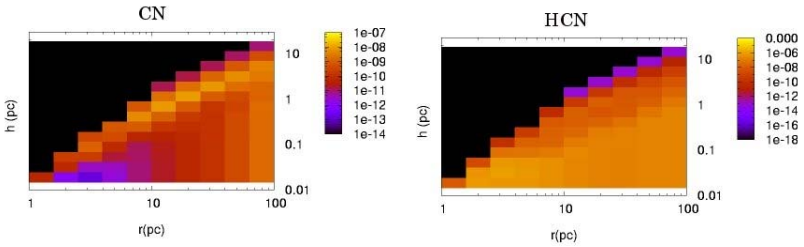

Figure 1: The fractional abundances of CN and HCN at different radius and height from the AGN core are shown.

References

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