Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

PPS025-12 Room:101 Time:May 23 17:15-17:30

Probing dust evolution in protoplanetary disks by near-infrared line ratios of molecular hydrogen emission

Hideko Nomura[1*], Yuhei Takagi[2], Yoichi Itoh[2], Koji Sugitani[3], Makoto Watanabe[4], Jeffrey S. Bary[5], David A. Weintraub[6], Yuri Aikawa[2], Masahiro Tsujimoto[7], Yoshitsugu Nakagawa[2], Tom J. Millar[8]

[1]Kyoto University, [2]Kobe University, [3]Nagoya City University, [4]NAOJ, [5]Colgate University, [6]Vanderbilt University, [7]JAXA/ISAS, [8]Queen's University Belfast

It is believed that planets are being formed from dust and gas in protoplanetary disks. Recent high spectral resolution and high sensitivity observations have made it possible to detect transition lines of molecular hydrogen in the disks. Meanwhile, historically, near-infrared H2 line ratios have been used as a tool to derive the physical properties of various astronomical objects.

In this work we have measured the 2-1 S(1)/1-0 S(1) H2 line ratios towards T Tauri stars to diagnose the H2 excitation mechanisms and the evolutionary status of dust grains in protoplanetary disks. By using Subaru/IRCS+AO188, we observed the 2-1 S(1) and 1-0 S(1) lines simultaneously with sufficiently high sensitivity and high spectral resolution. As a result, we have succeeded in constraining an upper limit of 0.14 for the 2-1 S(1)/1-0 S(1) H2 line ratio. Our result suggests that the molecular hydrogen is excited by thermal collisions, that is, the gas temperature is sufficiently high in the disk surface. The high gas temperature means that there will be enough amount of small dust grains which heat the gas via photoelectric effect induced by FUV photons. Comparison between the observational result and our model calculations suggests that dust-to-gas ratio in the disk surface relative to that in molecular clouds should be larger than 0.1. Results of our calculation of dust evolution show that this condition is satisfied if we take into account migration of dust particles from the outer disk towards the central star, which are coupled with viscously accreting gas. Also, we show that in this case dust particles accumlate at a particular point at the disk midplane, which makes a favorable condition for planetesimal formation.

Keywords: dust evolution, protoplanetary disks