NEAR-INFRARED PHOTOMETRIC MONITORING OF A PRE-MAIN-SEQUENCE OBJECT KH 15D. N. Kusakabe, *Department of Astronomical Science, Graduate University for Advanced Studies (Sokendai), (kusakabe@optik.mtk.nao.ac.jp)*, M. Tamura, Y. Nakajima, R. Kandori, A. Ishihara, L. Abe, *National Astronomical Observatory of Japan, Osawa, Mitaka, Tokyo 181-8588, Japan*, T. Nagata, T. Nagayama, *Department of Astronomy, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan*, S. Nishiyama, D. Baba, S. Sato, *Department of Astrophysics, Faculty of Sciences, Nagoya University, Chikusa-ku, Nagoya 464-8602, Japan*, K. Sugitani, *Institute of Natural Sciences, Nagoya City University, Mizuho, Nagoya 467-8501, Japan*, E. E. Turner, *Princeton University Observatory, Peyton Hall, Princeton, NJ 08544*.

An extensive photometric monitoring of KH 15D [1], an enigmatic variable in the young star cluster NGC 2264, has been conducted. Simultaneous and accurate near-infrared (*JHKs*-bands) photometry is presented between 2003 December and 2005 March covering most of the variable phase. The infrared variability is characterized by large-amplitude and long-lasting eclipse, as observed at optical. The period of variability is 48.3 ± 0.2 days, the maximum photometric amplitude of variability is ∼4.2 mag, and the eclipse duration is ∼0.5 in phase units. These are consistent with the most recent period, amplitude, and duration at optical. The blueing of the *J-H* color (∼0.17 mag) during the eclipse is unambiguously confirmed, which has been marginally suggested before, while that of the *H-Ks* color is less clear but seems to be at the same level. The overall shape of the *JHKs* light curves (Figuer 1) is very similar to the optical one, including a fair time-symmetry and a less stable flux during the eclipse with a slight hump near the zero phase.

The most plausible model of these enigmatic variable features of KH 15D is the theory that a binary star in a mutual orbit with high eccentricity is gradually occulted by an inclined and precessing circumbinary disk [2] or narrow ring [4].The existence of such a companion has been recently confirmed by radial velocity measurements [3]; the orbital parameters well agree with the prediction by Winn et al. (2004). The long-term change of the variabilty characteristics revealed by archival studies [4-6] is also explained with the same idea. Today we can see only one of the binary which consists of the visible eclipsing one (Star A) and the totally invisible one (Star B). By employing this theory, we consider the near-infrared and optical features that are explainable as follows:

(a) Both the large variability amplitude and the long-lasting periodic eclipse that are almost independent of the observed wavelengths (*VRIJHKs*) are well explained with a gradual occultation by a knife edge screen. In this case, the screen is either a circumbinary disk or ring, and the disk dust size responsible for the screening must be much larger than the observed wavelengths ($\gg 2$ μm).

(b) The blueing can also be explained by the eclisping disk model with an outer scattering region. This is consistent with the increase of optical polarization during the eclipse which suggests that entire fraction of the light in eclipse is scattered light [7]. The polarization data suggest that the scattering region is not completely obscured by the occulting material. Since the blueing is observed not only at *JHKs* but also at *VRI* [8], the dust size responsible for the scattering, which is distinct from the screening dust mentioned above, must be small ($a < \lambda/2\pi \sim 0.1$ μm), comparable to the interstellar dust size.

(c) The hump near ϕ = 0 is probably due to some flux contribution of the unseen star (Star B) of the binary in the Winn's model because the Star B is nearest to the occulting edge at the middle of the eclipse. The amplitude is ∼0.5 mag at *JHKs*, almost identical to the amplitude at *I* (in 2002-2003, [6]). The *J-H* color tends to be slightly redder near this hump compared with other eclipsing color, which might support the interpretation that some additional light (from Star B) increases at this time.

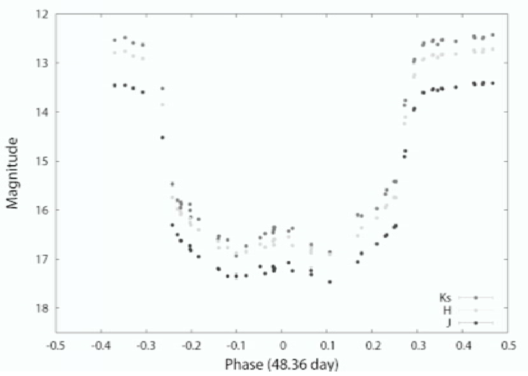

Figure 1: Phased light curves of KH 15D (*JHKs*) from 2003 December to 2005 March. The period of 48.36 days is used for phasing.

References: [1]Kearns, K. E., & Herbst, W. 1998, AJ, 116, 261 [2]Winn, J. N., et al. 2004, ApJ, 603, L45 [3]Chiang, E. I., & Murray-Clay, R. A. 2004, AJ, 607, 913 [4]Johnson, J. A., et al. 2004, AJ, 128, 1265 [5]Johnson, J. A., & Winn, J. N. 2004, AJ, 127, 2344 [6]Johnson, J. A., et al. 2005, AJ, 129, 1978 [7]Winn, J. N., et al. 2003, ApJ, 2003, 593, L121 [8]Agol, E., Barth, A. J., Wolf, S., & Charbonneau, D. 2004, ApJ, 600, 781 [9]Herbst, W., et al. 2002, PASP, 114, 1167 [10]Allen, D. 1972, ApJ, 172, L55 [11]Barsunova, O. Y., Grinin, V. P., & Sergeev, S. G. 2005, Astrophysics, 48, 1 [12]Deming, D., Charbonneau, D., & Harrington, J. 2004, ApJ, 601, L87 [13]Hamilton, C. M., Herbst, W., Shih, C., & Ferro, A. J. 2001, AJ, 554, L201 [14]Knacke, R., Fajardo-Acosta, S., & Tokunaga, A. T. 2004, AJ, 128, 2977 [15]Maffei, P., Ciprini, S., & Tosti, G. 2005, MNRAS, 357, 1059 [16]Nagashima, C., et al. 1999, in Star Formation 1999, ed. T. Nakamoto (Nobeyama: Nobeyama Radio Obs.), 397 [17]Nagayama, T., et al. 2003, Proc. SPIE, 4841, 459 [18]Nakajima, Y., et al. 2005, AJ, 129, 776 [19]Persson, S. E., et al. 1998, AJ, 116, 2475 [20]Tokunaga, A. T. et al. 2004, ApJ, 601, L91