On the Reddening Law Observed for Type Ia Supernovae

Takaya Nozawa[1]

[1]*National Astronomical Observatory of Japan, Japan*

The reddening of Type Ia supernovae (SNe Ia) by dust grains is one of the largest uncertainties that limit the current precision of the cosmological parameters. In particular, the total-to-selective extinction ratios, Rv, along the lines of sight to SNe Ia are known to be considerably low (Rv=1.0-2.0), compared to the average value (Rv=3.1) in the Milky Way. The origin of such an unusually low Rv is thus an important issue to be resolved for the applicability of SNe Ia as the cosmic standard candles, and also casts challenging problems in modelling the extinction properties by dust grains as well as the intrinsic emission spectrum of SNe Ia.

Many researchers have believed that the low Rv observed for SNe Ia is the consequence of the scattered light echo, i.e., multiple scattering of photons in the circumstellar dust shell with an optical depth of $\tau v \sim 1$ in V band (Wang 2005, ApJ, 635, L33; Goobar 2008, ApJ, 686, L103). If there are such moderately optically thick dust shells around SNe Ia, we also expect the infrared (IR) light echo, i.e., thermal emission from circumstellar dust heated by the SN radiation. Johansson et al. (2013, MNRAS, 431, L43) observed three nearby SNe Ia about a few months post-explosion with *Herschel*, but only gave an insignificant upper limit of M_{dust}~0.01 M_{sun} as the mass of circumstellar dust. This limit is well above $M_{dust}=10^{-4}$ Msun, with which circumstellar dust can cause an unusually low Rv through the multiple scattering (Amanullah & Goobar 2011, ApJ, 735, 20).

In this talk, we report the MIR photometric observations of SN 2014J about one year after the explosion with Subaru COMICS. SN 2014J is a normal Type Ia supernova discovered on 21 Jan in 2014, and the distance to the host galaxies (M82) is 3.5 Mpc, which is the nearest among SNe Ia reported in the last thirty years. This SN is highly reddened and indicates a low value of Rv =1.4 (Amanullah et al. 2014, 788, L21). Therefore, given its close proximity and high extinction, SN 2014J offers the best opportunity to date to search for the circumstellar dust.

From the results of this IR observation, we will show the distribution of the dust shell around SN 2014J or we will put much better constraints on the upper mass limit of circumstellar dust than that (M_{dust}~10^{-2} Msun) from the previous work with *Herschel*. We note that the non-detection of IR light-echo can allow us to conclude that a very low Rv seen in SNe Ia cannot be due to the multiple scattering by circumstellar dust, so it must be the interstellar dust origin. We also discuss the properties of interstellar dust to reproduce the reddening law as low as Rv =1.4.