Dust Formation by Evolved Massive Stars based on Observations with Subaru/COMICS

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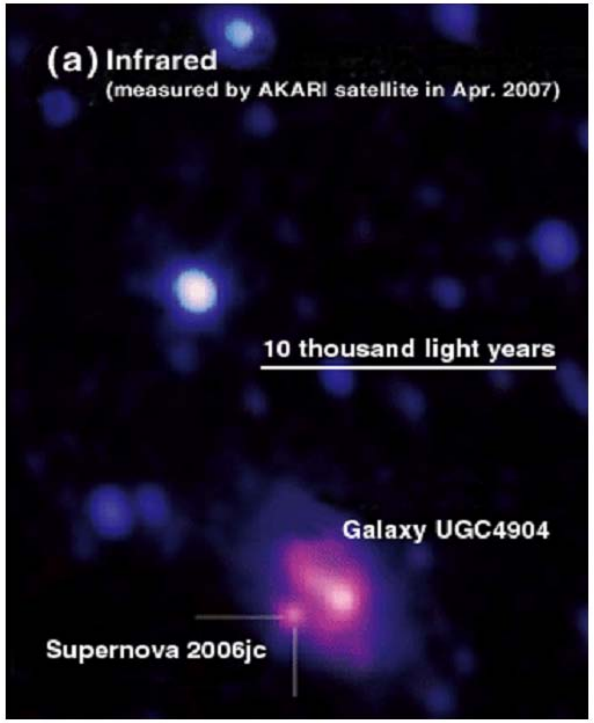
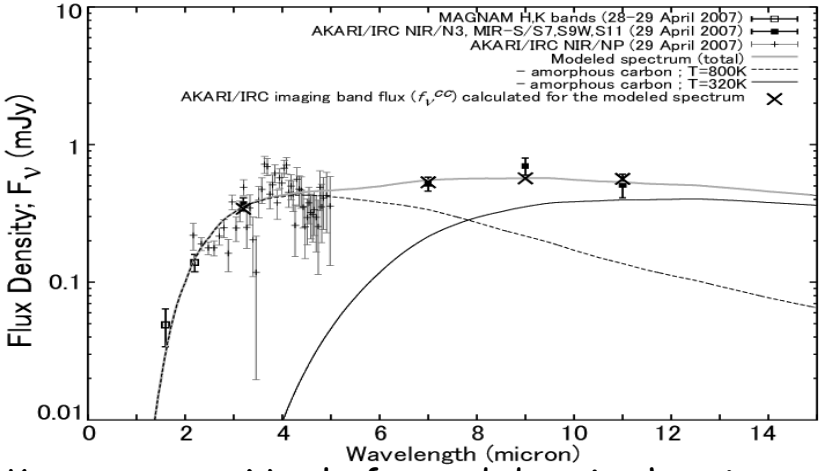
1. Dust formation by SN2006jc

An Example of the Latest Results on the Dust Formation by Core-collapse SNe

AKARI/Infrared Camera (IRC) observations of SN2006jc in UGC4904



[3μm(blue), 7μm(green), 11μm(red)]



800K component; Newly formed dust in the ejecta of SN2006jc

$T_{hot.car.} = 800 \pm 10$ (K)

$M_{hot.car.} = 6.9 \pm 0.5 \times 10^{-5}\ M_{solar}$

300K component; pre-existing circumstellar dust

$T_{warm.car.} = 320 \pm 10$ (K)

$M_{warm.car.} = 2.7^{+0.7}_{-0.5} \times 10^{-3}\ M_{solar}$

→ The amount of newly formed dust is more than 3 orders of magnitudes smaller than the amount needed for a SN to contribute efficiently to the early-Universe dust budget

→ Dust condensation in the mass loss wind associated with the prior events to the SN explosion could make a significant contribution to the dust formation by a massive star in its whole evolutional history (Sakon et al. 2009, ApJ, 692, 546).

2. Dust Emission around SN2008ax

SN2008ax in NGC 4490 (d = 9.6Mpc; Pastorello et al. 2008)

Type IIb (Chornock et al. 2008) discovered by Mostardi et al.(2008) on 2008 Mar 3.45

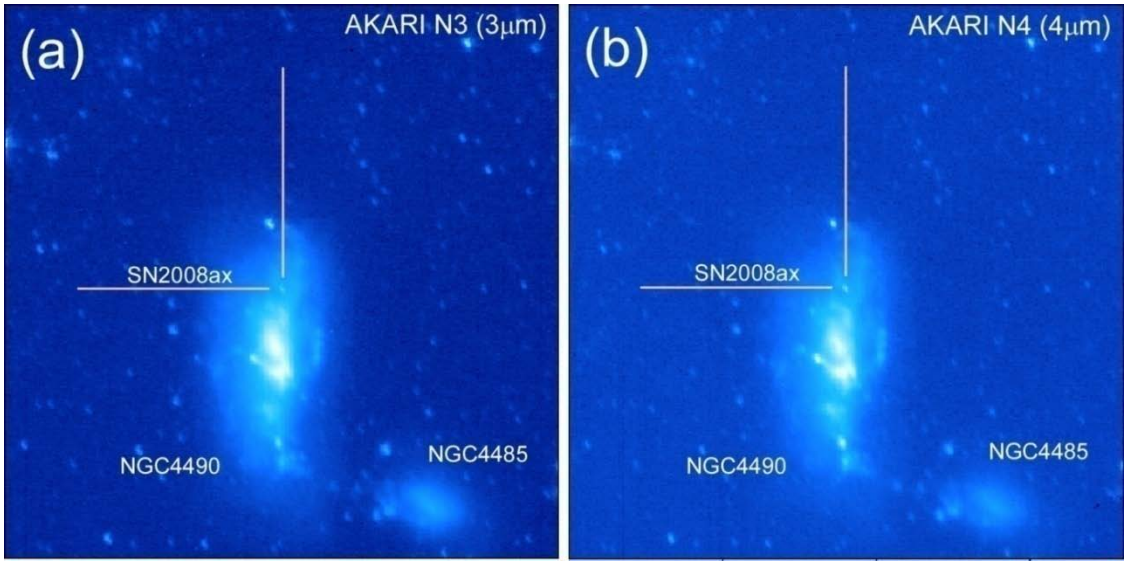
-- the optical light curve resembles that of the He-rich Type IIb SNe 1996cb and 1993J

-- an OB/WR progenitorstar (M_{ms} = 10-14$M_{\odot}$) in an interacting binary system

→ properties of the circumstellar dust shell

→ Possible dust formation in the SN ejecta

NIR imaging and spectroscopy of SN2008ax with AKARI/IRC on ~100days



0.33±0.03 mJy at N3(3μm) and 0.41±0.03 mJy at N4(4μm) bands

→ $T_{a.car.}$=767±45K; $M_{a.car.}=1.2^{+0.4}_{-0.3}\ 10^{-5}\ M_{\odot}$

→ $T_{a.sil.}$=885±60K; $M_{a.sil.}=6.8^{+2.5}_{-1.7}\ 10^{-5}\ M_{\odot}$

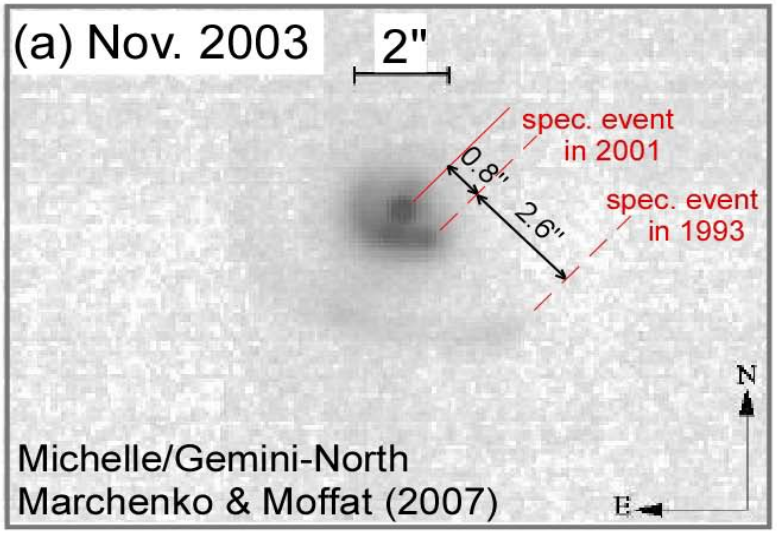
Infrared light echo from the dust formed as a result of the WR binary activities

3. Dust formation by Wolf-Rayet Binaries

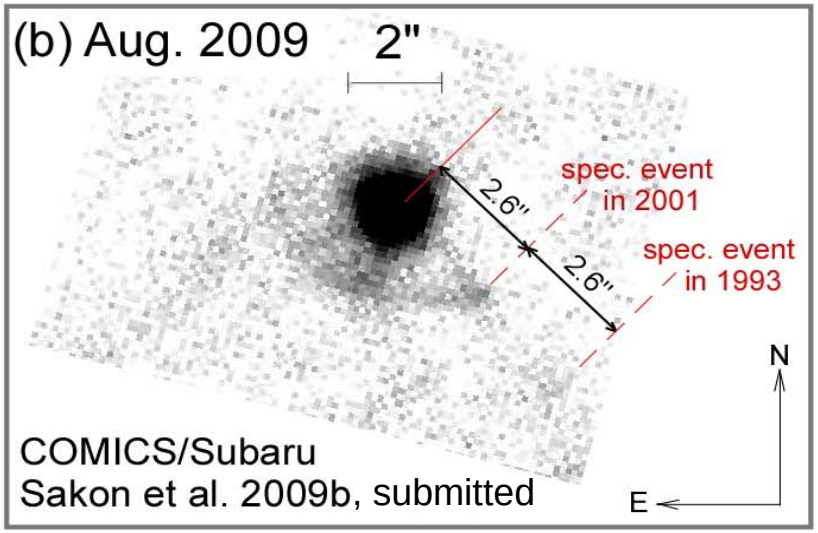
WR140; long-period (P=7.93y; Marchenko et al. 2003) colliding-wind WR binary
(WC7 class Wolf-Rayet star + O4 type star) located at d~1.1kpc

"spectroscopic events" in 1993, 2001 and 2009

Observations; Cooled Mid-infrared Camera and Spectrometer (COMICS) / Subaru
N-band imaging and low-resolution spectroscopy of WR140
; 1st Aug. in 2009 (executed) & 2nd Nov. in 2009



12.5μm image of WR140 taken with Michelle/Gemini-North on Nov. – Dec. in 2003 (Marchenko & Moffat 2007).

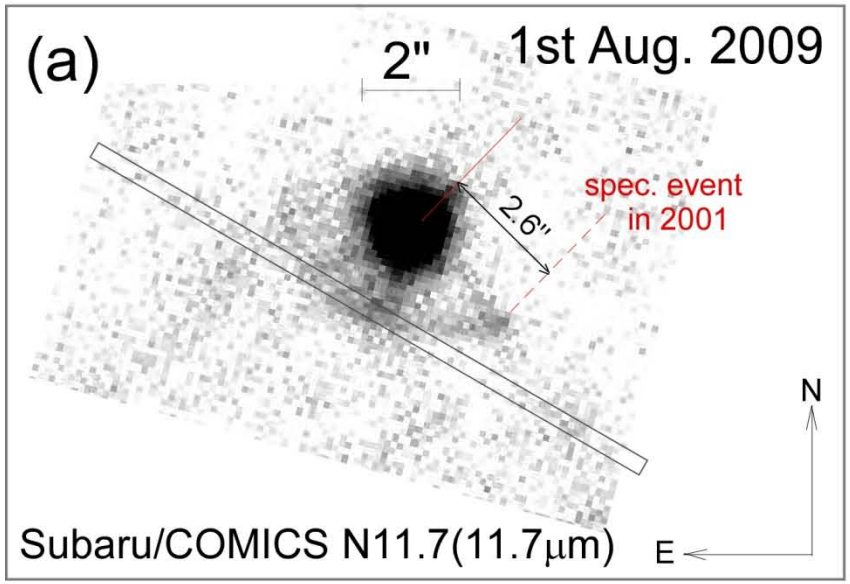


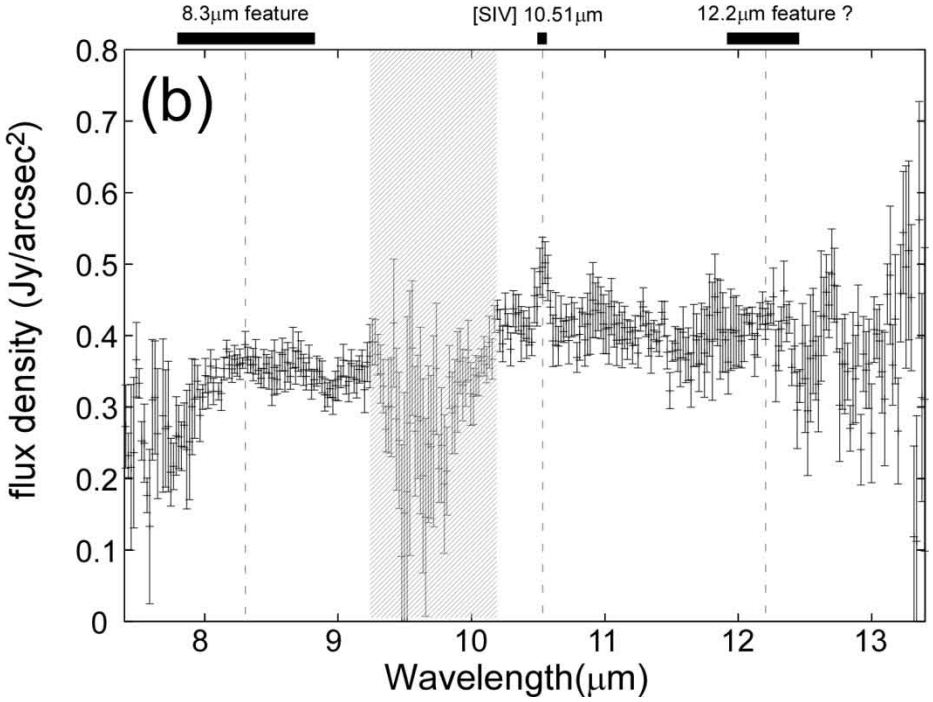
11.7μm image of WR140 taken with COMICS/Subaru on 1st Aug. in 2009 (Sakon et al. 2009b, submitted).

→ The expansion velocity of the dust shell; $1.6 \pm 0.2 \times 10^3$ km s^{-1}

3. Dust formation by Wolf-Rayet Binaries

A Result of the N-band Low-resolution Spectroscopic Observations
of dust shells formed as a result of the previous spectroscopic events





-- broad dust band features at ~8.3μm and ~12.2μm
- similar broad band features are found in NGC300-OT(Prieto et al. 2009)
- Hydrogenated amorphous carbons seen in C-rich proto PNe

Continuous mid-infrared spectroscopic observations of periodically dust-making WR binaries with Subaru/COMICS is essential to understand the chemical evolution of dust formed around the massive stars during its evolutional history