Herschel and ALMA measurements of Dust and Molecules in Supernova 1987A

M. Meixner (STScI,JHU), R. Indebetouw (UVa,NRAO), M. Matsuura (UCL), J. Kamenetzky & R. McCray (UColorado), E. Dwek & G. Sonneborn (NASA/Goddard), G. Zanardo & L. Staveley-Smith & T. Potter(ICRAR), M. Barlow & J. Yates & B. M. Swinyard (UCL) B. Arbutina & D. Urosevic & V. Zekovic (U Belgrade) A. Bolatto (UMD),C. Vlahakis & R. Wesson (ESO), R. Chevalier (UVa),C. Fransson (Stockholm Univ), D. Burrows (Penn State), M. Baes & J. Verstappen & I. De Looze &G. Gentile & J. Fritz (Univ. of Gent), P. Bouchet, K. Okumura, K.A. Misslet, M. Sauvage (CEA/Saclay) , H.L. Gomez (Cardiff Univ.), T. Lim (RAL), M.A.T. Groenewegen & G. Van de Steene & P.A.M. van Hoof (ROB), P. Royer (Inst. voor Sterrenkunde), G. Clayton & E. Montiel (LSU), B. Gaensler (Univ. of Sydney), R. Kirshner & A. Soderberg (Harvard), M. Lakićević & J. van Loon (Univ. of Keele), K. Long, J. Roman-Duval, K. Gordon (STScI), P. Lundqvist (Stockholm Obs.), I. Martí-Vidal (Chalmers Univ. of Tech), J. Marcaide (Univ. de Valencia), C.-Y. Ng (Univ. of Physics, Hong Kong), S. Park (Univ. of Texas, Arlington), M. Otsuka (ASIAA), K. Sandstrom & S. Hony(MPIA), B. Babler (Univ. of Wisc.), T. Nozawa (Univ. of Tokyo)

Dust production by supernovae is important in the dust life cycle of a galaxy. The explosion of SN 1987A was the nearest SN detected in the last 400 years, allowing us detailed studies of contemporary evolution of supernova for the first time. In 2011, Matsuura et al. reported 0.4-0.7 solar masses of dust in SN 1987A based on Herschel HERITAGE survey data which is surprisingly large compared to prior measurements of supernovae. In this paper, we present our followup studies of this important discovery about SN 1987A using the Herschel Space Observatory and Atacama Large Millimeter Array (ALMA). We highlight two important results, the detection of cold molecular gas and dust in the ejected material of SN 1987A. Our results suggest that SNe are significant produces of dust and molecules, as well as heavy elements, driving chemical evolution of galaxies.