A New Approach to Study Supernovae Dust with SPICA

AKARI/IRC

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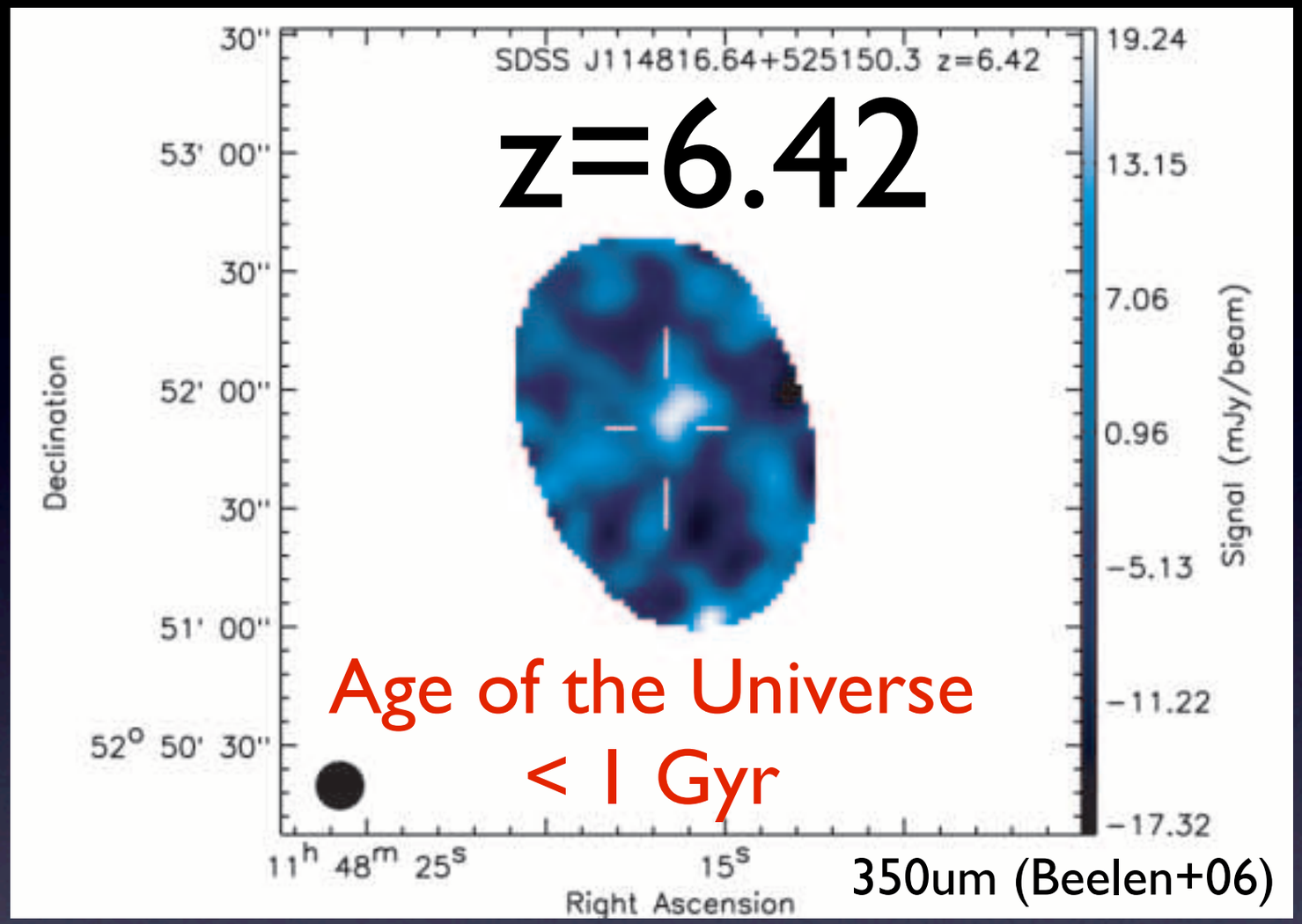
Do Supernovae Form Dust in the Early Universe?

Origin and Evolution of Cosmic Dust

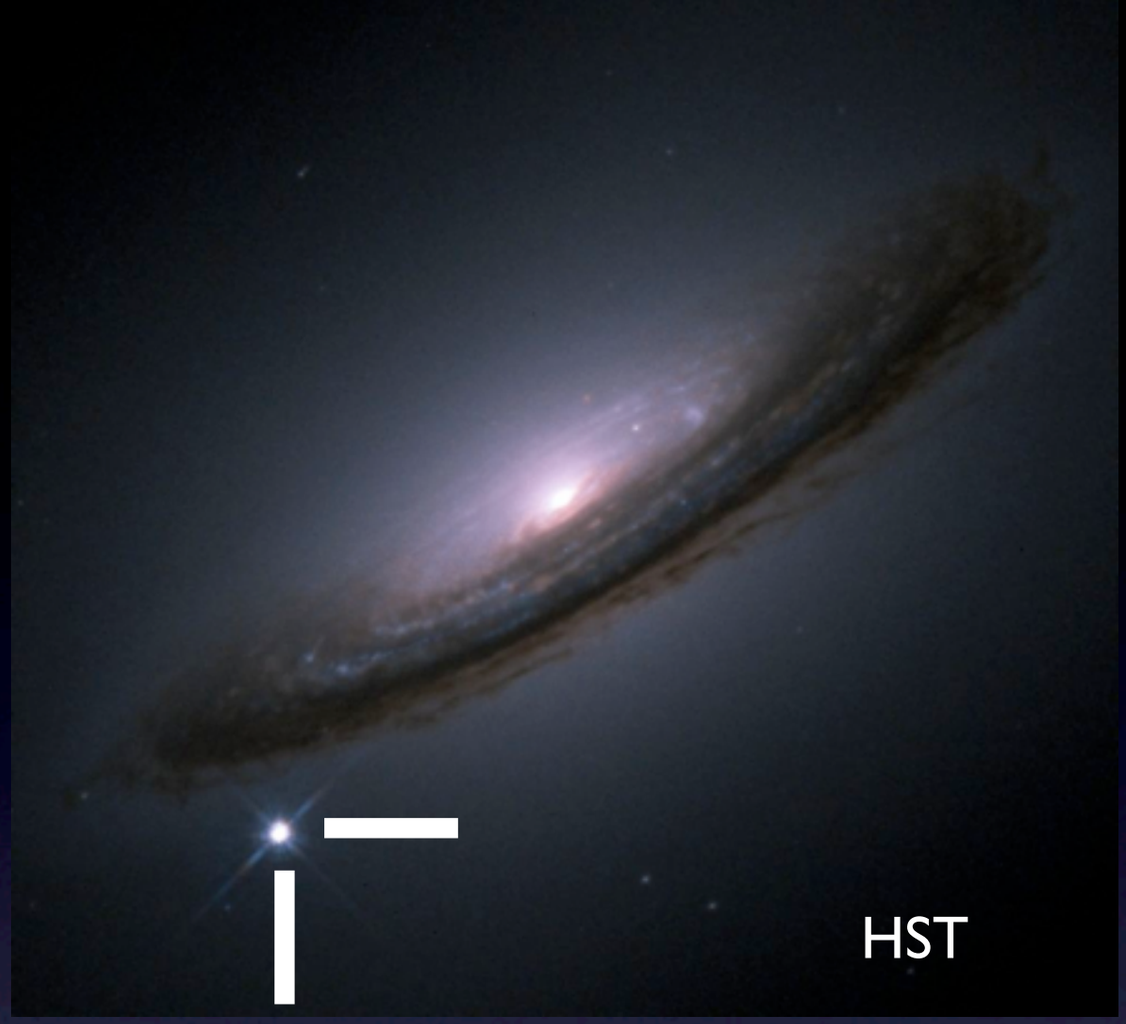


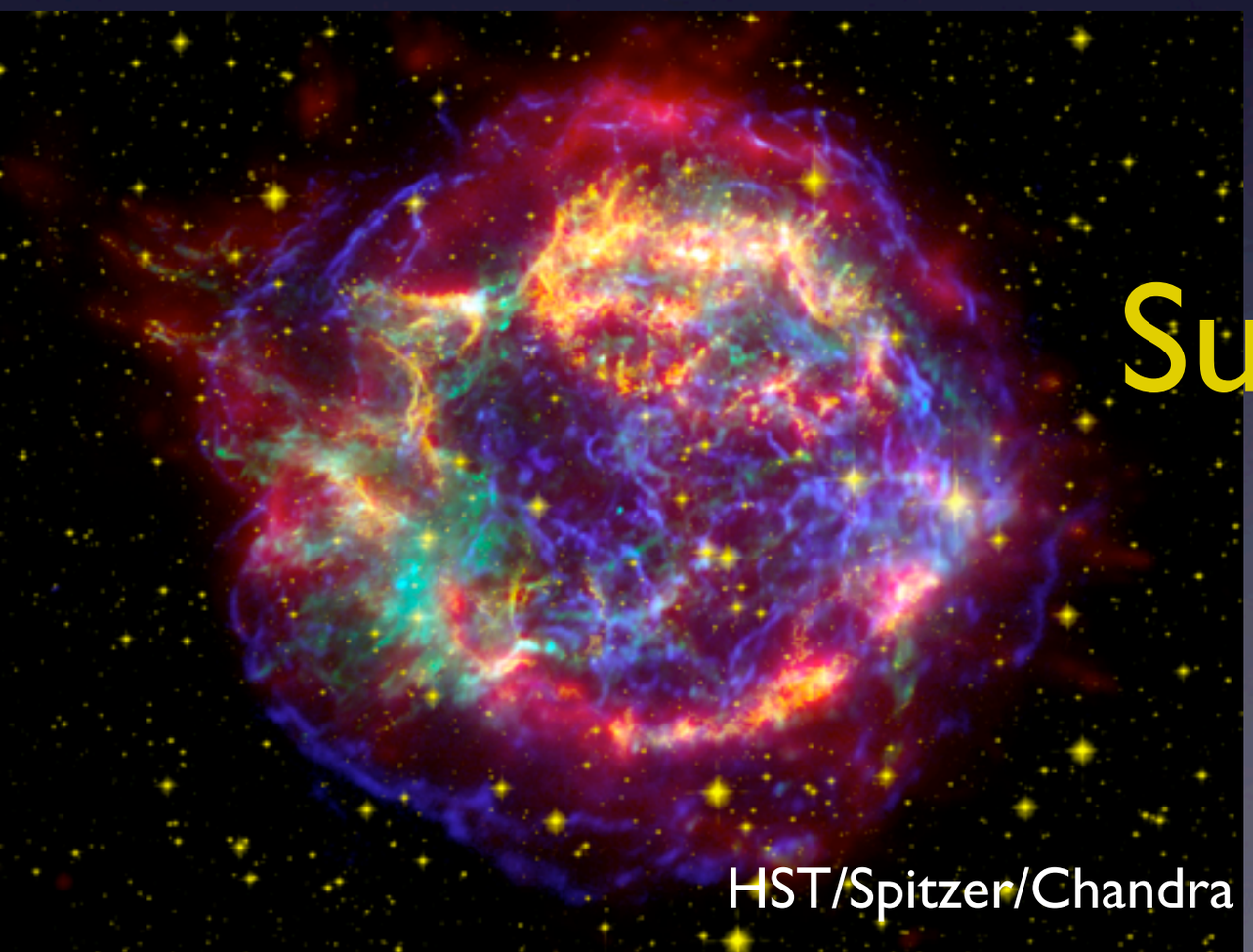
Mdust ~ **0.1**-1 Msun/SN
(Dwek+07)

Theory ~ 0.1 Msun/SN
(Todini+01, Nozawa+03)

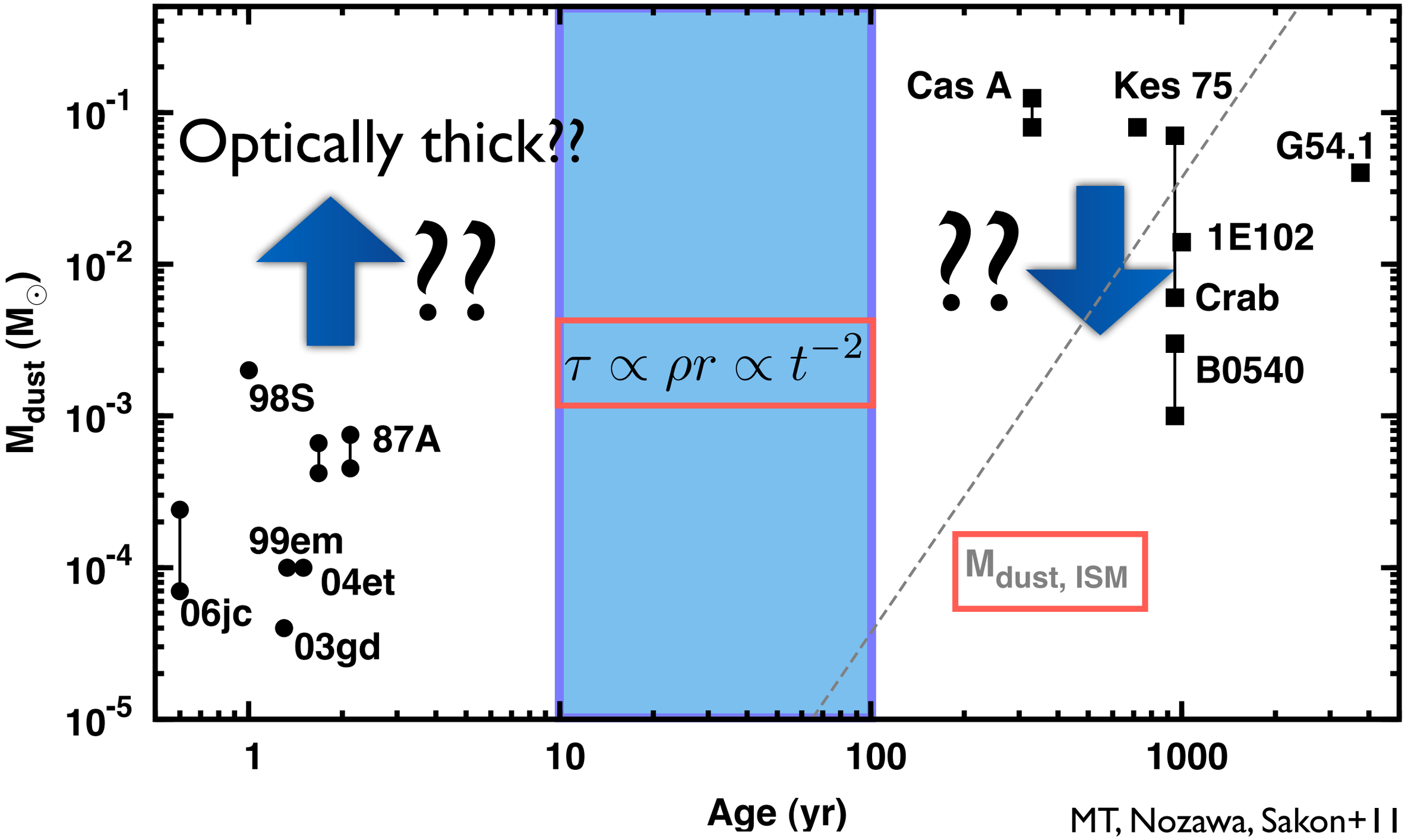
Flat extinction curve
in quasars @ z~6
(e.g., Maiolino+04)

Young Supernovae
(age ~ 1-2 yr)
10^{-4} Msun





Supernova Remnants
(age > 300 yr)
10^{-1} Msun

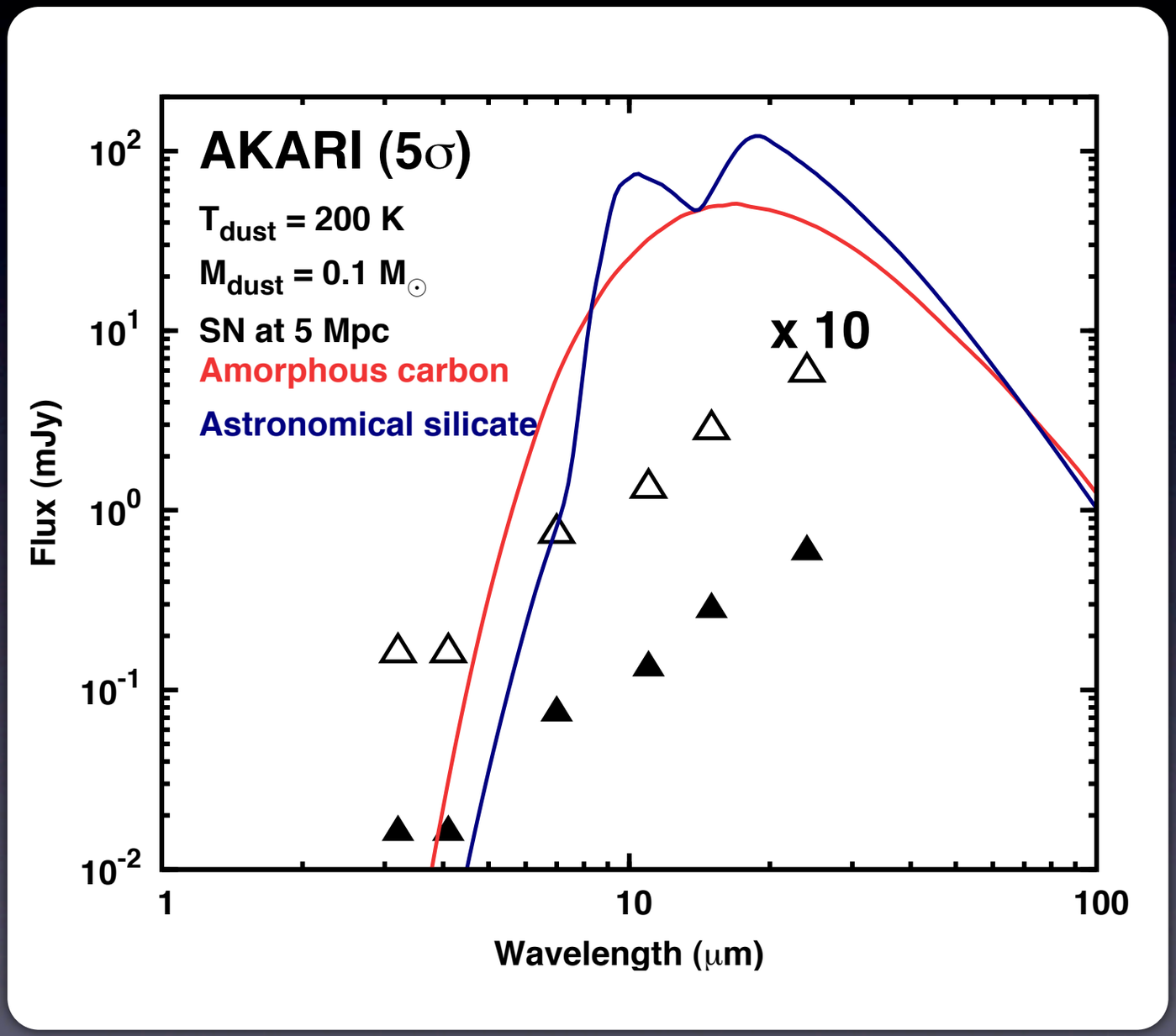


Young supernovae: Ercolano+07, Wooden+93, Pozzo+04, Elmhamdi+03, Meikle+07, Kotak+09, Mattila+08, Sakon+09

Supernova remnants: Rho+08, Sibthorpe+10, Barlow+10, Nozawa+10, Morton+07, Green+04, Temim+06, Rho+09, Sandstrom+09, Williiams+08, Temim+10

Search for Dust in "Middle-Aged" Supernovae!!

How Crazy We Are



AKARI/IRC 3, 7, 15um

SN 1909A

SN 1951H

M101
(6.7 Mpc)

SN 1968D

SN 1980K

SN 1917A

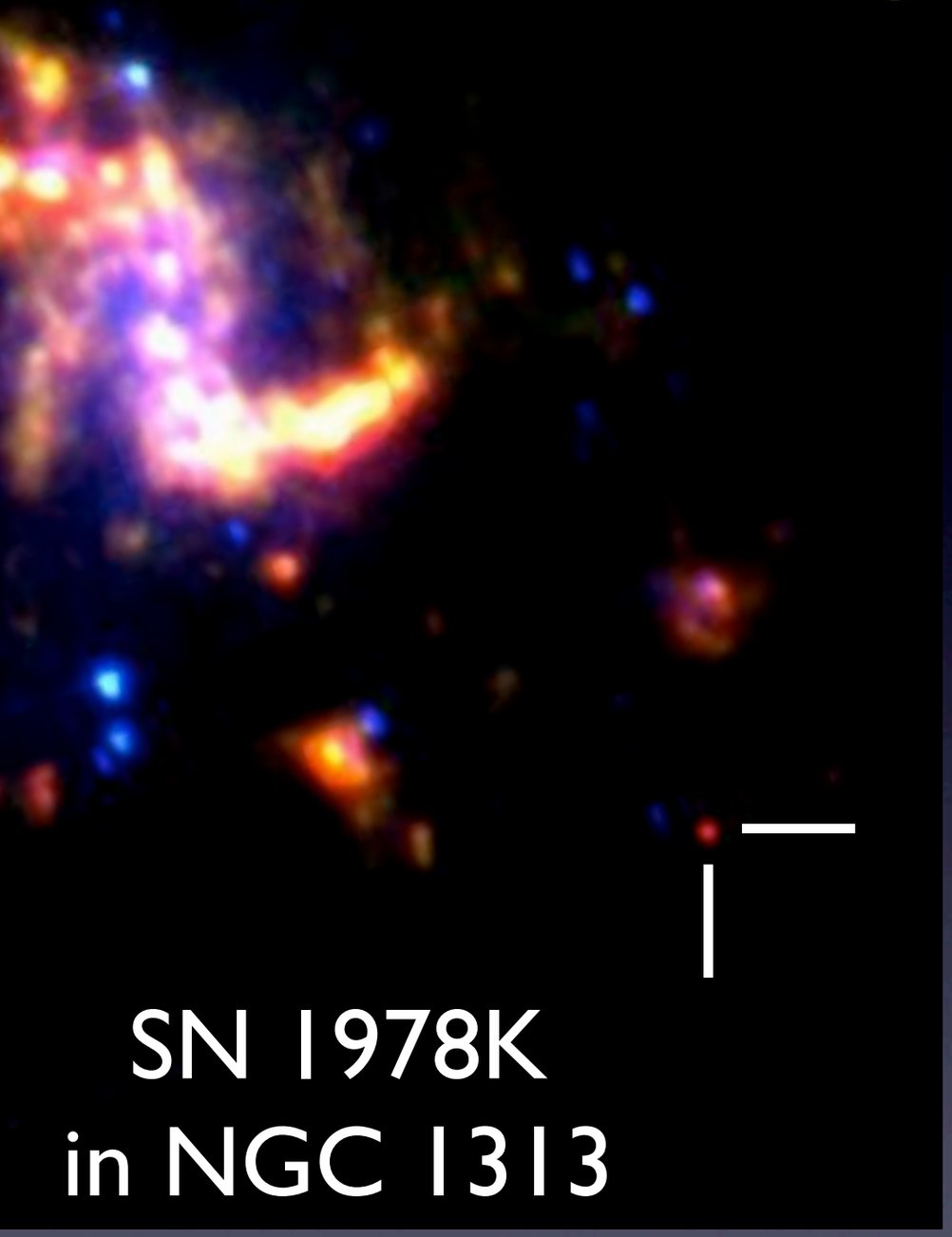
NGC 6946
(5.6 Mpc)

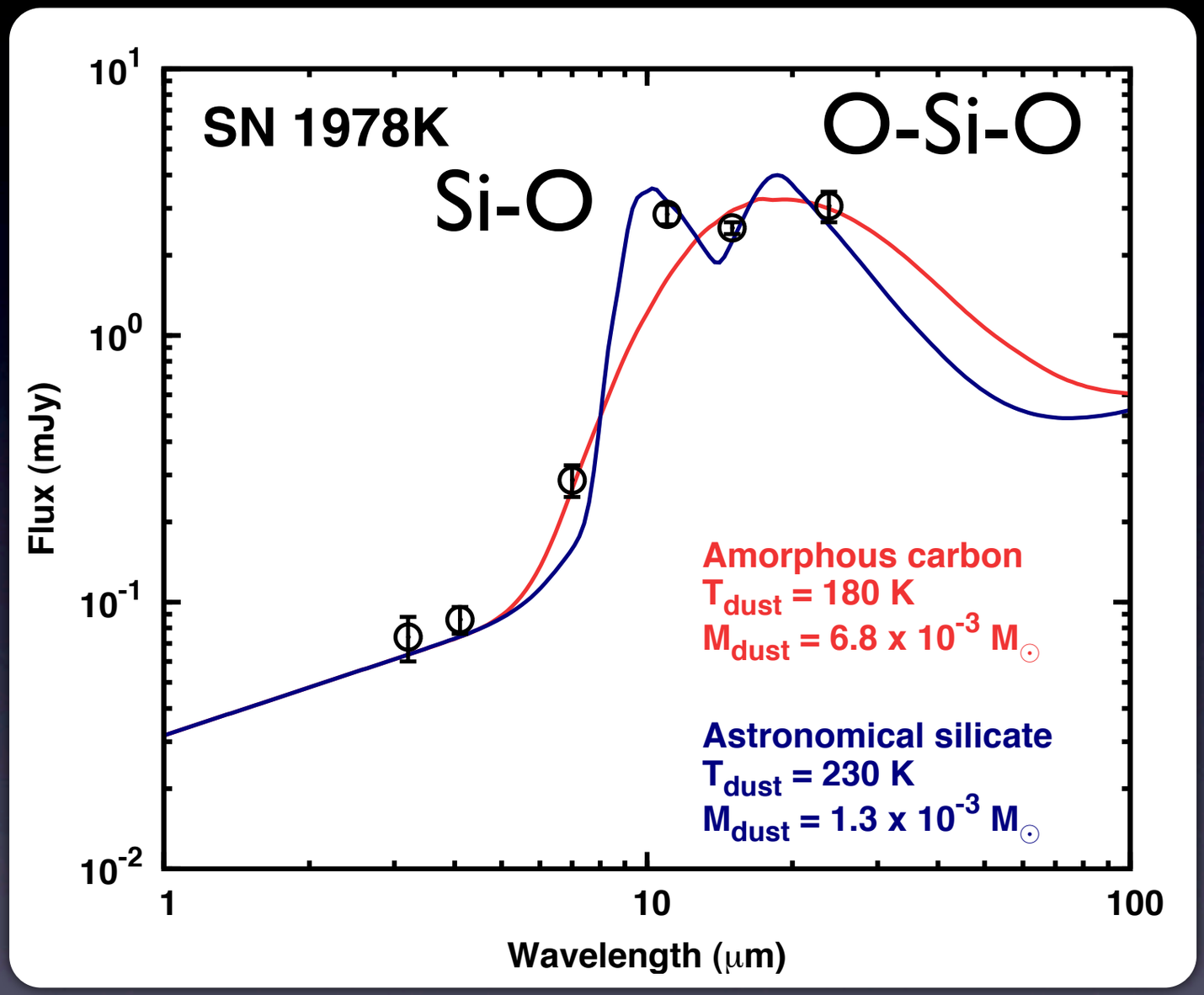
SN 1962M

NGC 1313
(4.1 Mpc)

SN 1978K

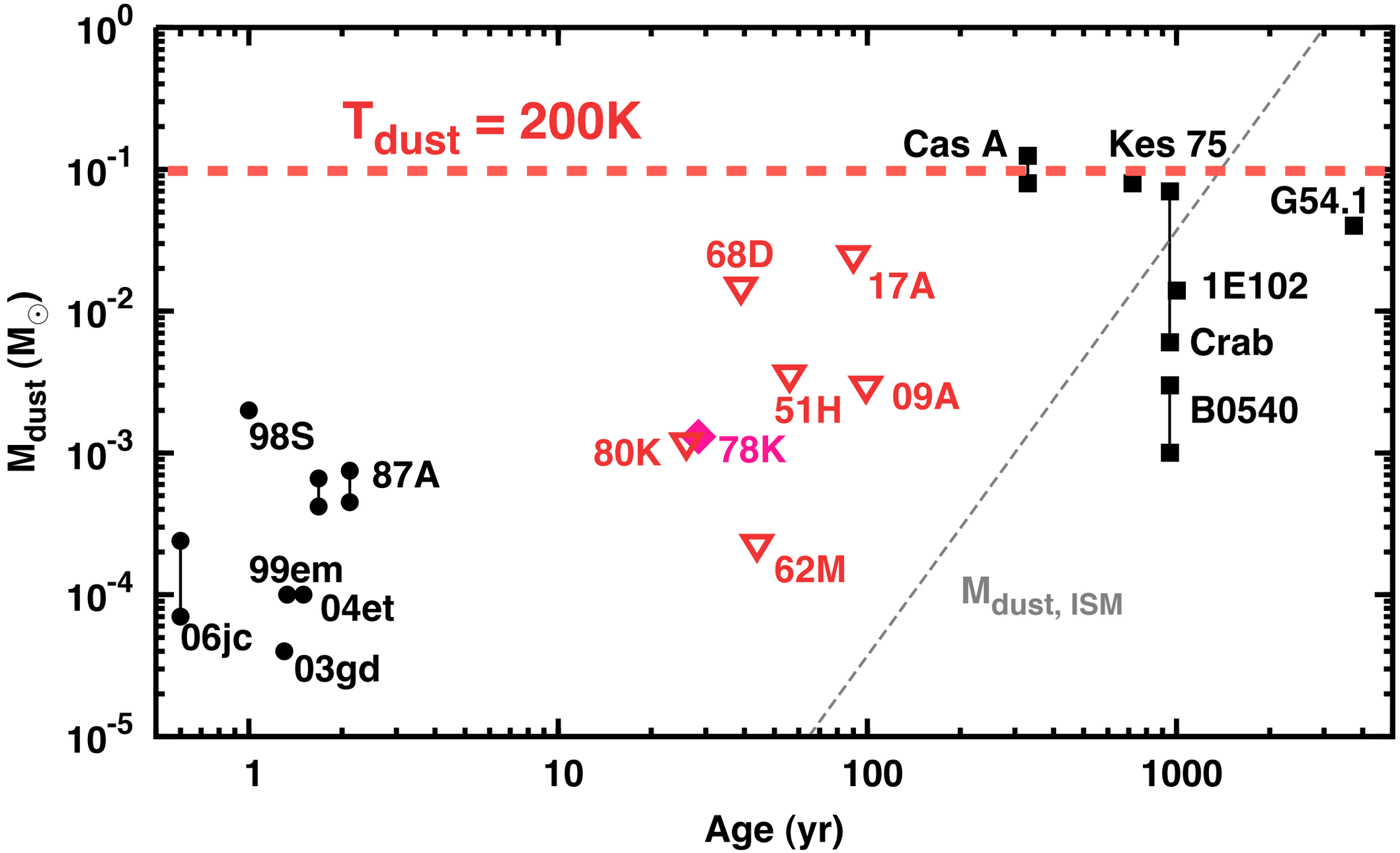
Detected!!

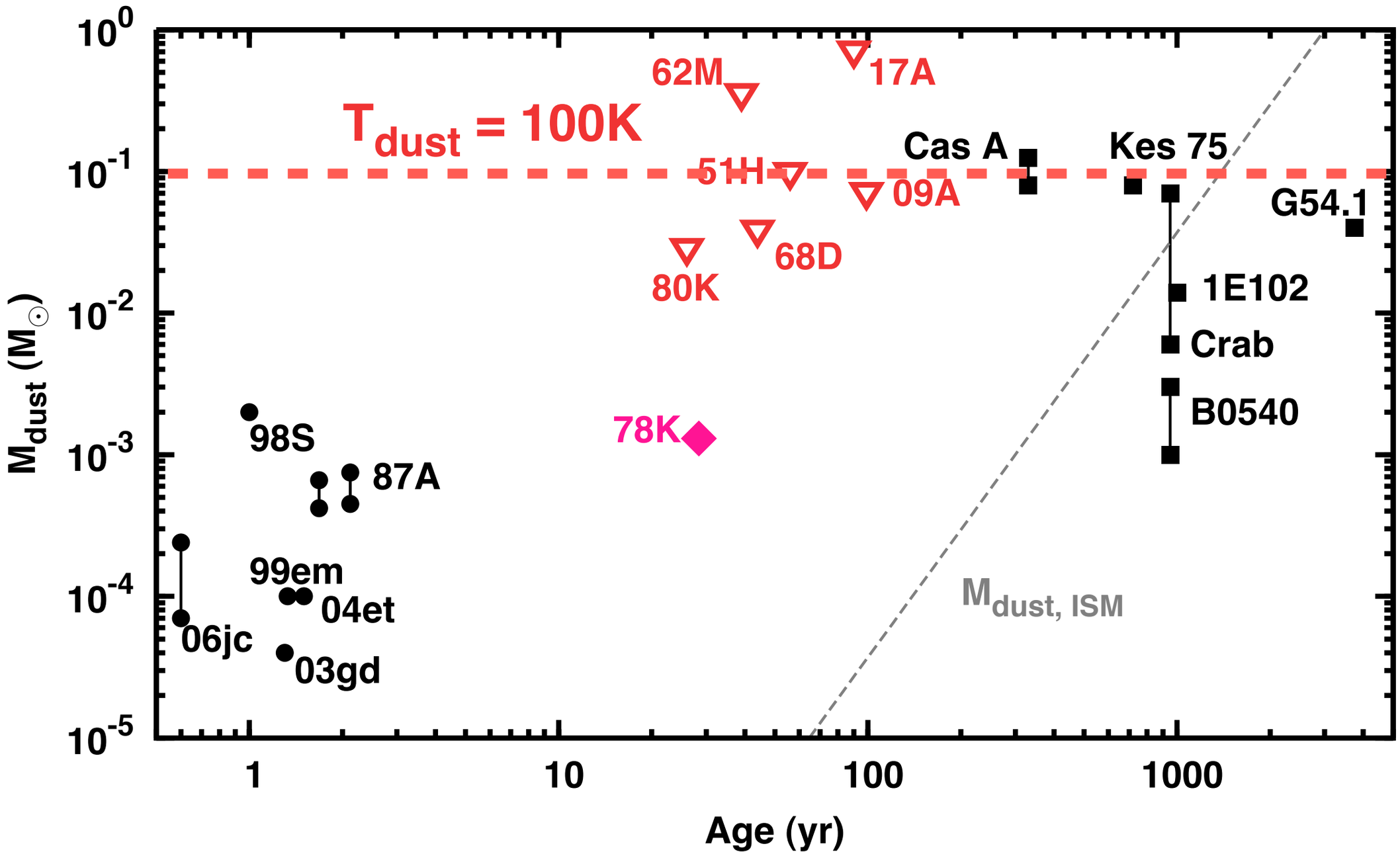




Silicate dust M ~10^{-3} Msun (T ~ 200K)

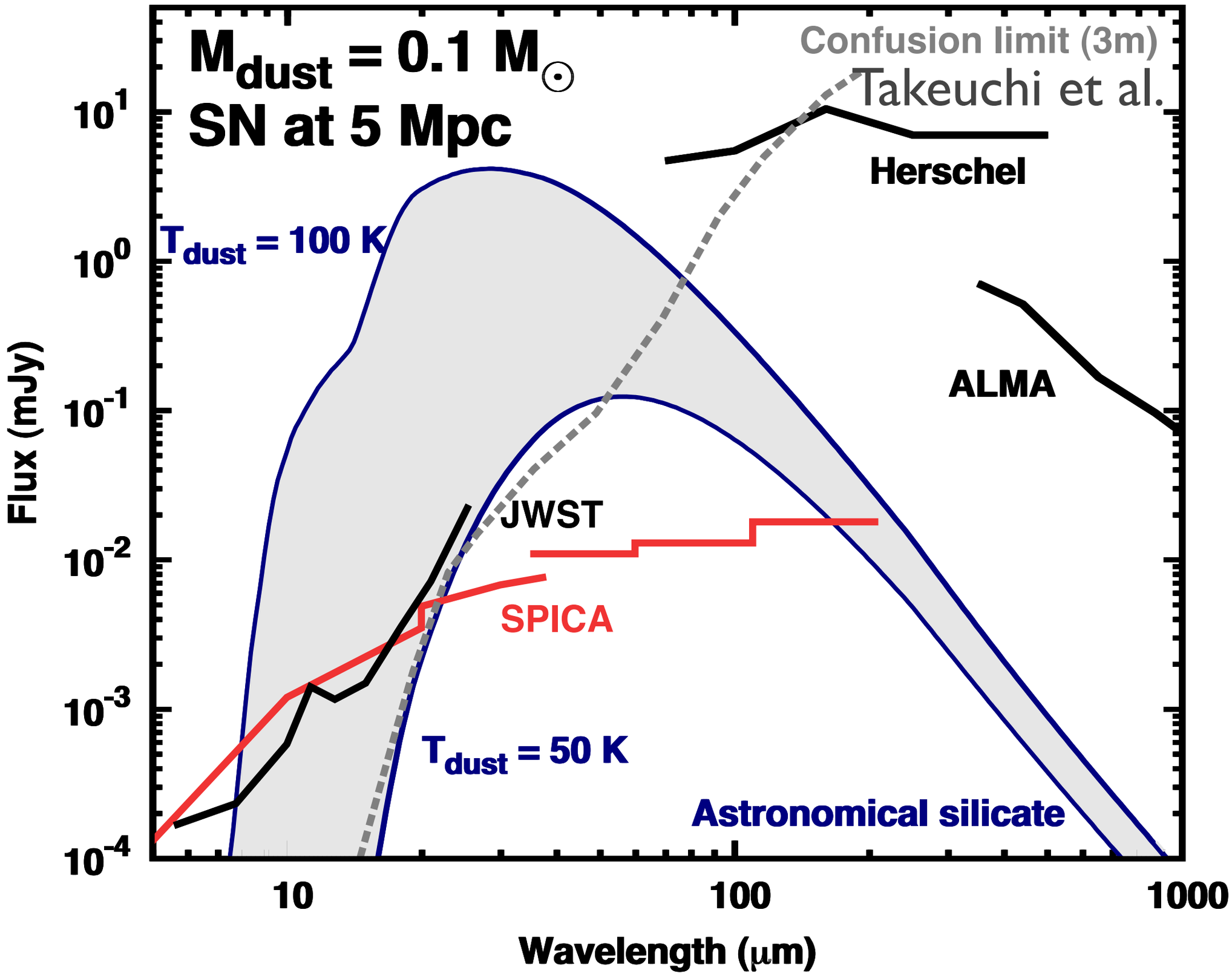
NOTE: Cooler dust can be hidden!

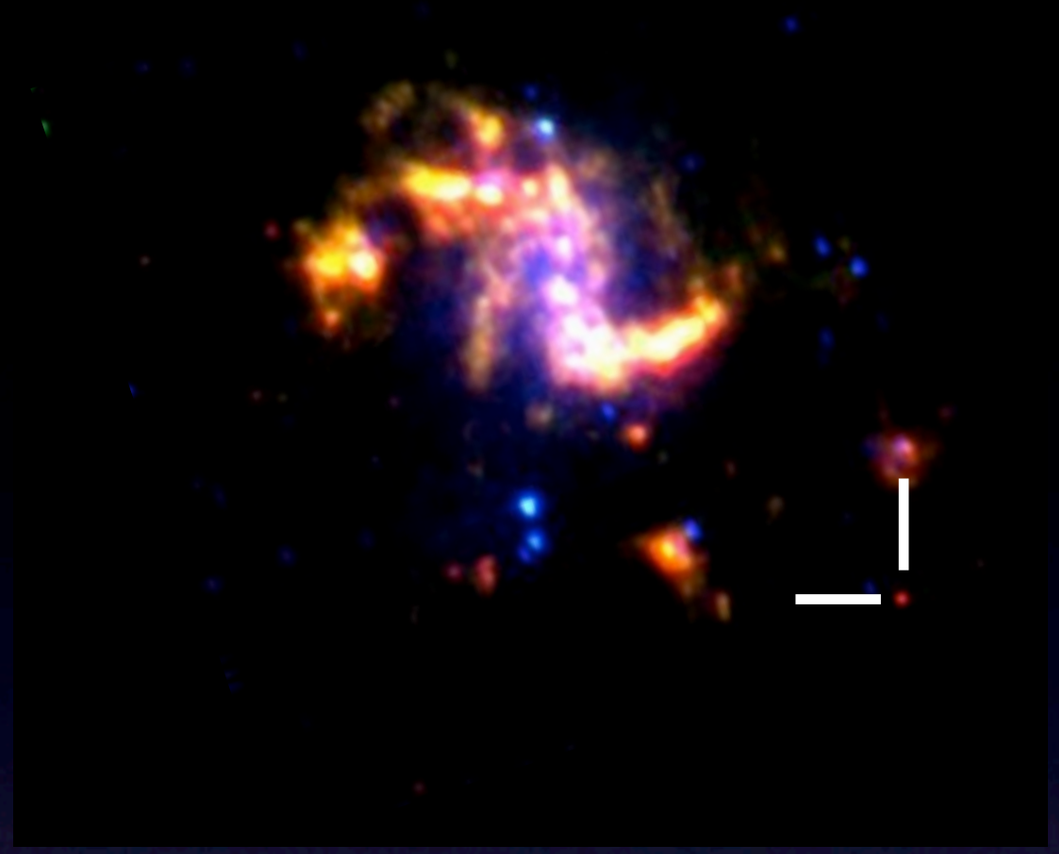

10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
M_{dust} ($M_\odot$)
T_{dust} = 200K
Cas A
Kes 75
G54.1
1E102
Crab
B0540
68D
17A
51H
09A
80K
78K
62M
98S
87A
99em
04et
06jc
03gd
$M_{dust, ISM}$
1
10
100
1000
Age (yr)


10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
M_{dust} ($M_\odot$)
T_{dust} = 100K
62M
17A
51H
09A
80K
68D
78K
Cas A
Kes 75
G54.1
1E102
Crab
B0540
98S
87A
99em
04et
06jc
03gd
$M_{dust, ISM}$
1
10
100
1000
Age (yr)

0.1 Msun of Dust can be Hidden Only If T < 80-100 K

5 σ detection limit (1 hr exposure)





SPICA will give the answer to the question whether SNe produce dust in the early Universe

- Imaging observations of nearby galaxies (incl. outskirt)
- Coverage from MIR to FIR is essential
- ~ 10 targets at ~< 5Mpc