



The dust budget crisis in high redshift submillimetre galaxies

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Submillimetre galaxies

$z \sim 2$ (Chapman +05,
Lapi +11, Wardlow +11)

$$M_* \sim 10^{11} M_{\odot}$$

$$L_{\text{IR}} = > 10^{12-13} L_{\odot} \text{ (ULIRGs)}$$

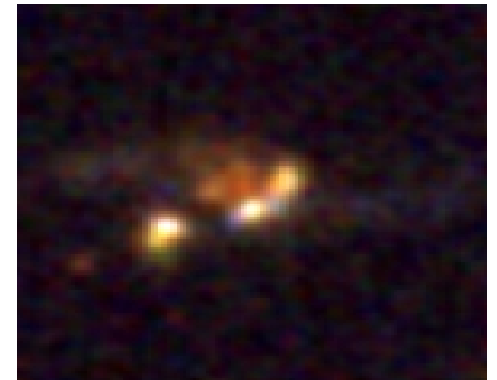
$$\text{SFR } 100\text{-}1000 M_{\odot}/\text{yr}$$

Gas fractions $\sim 40\text{-}50\%$ (Tacconi +06, 08)

Progenitors of massive local ellipticals? (e.g. Swinbank+06)



Targett+12



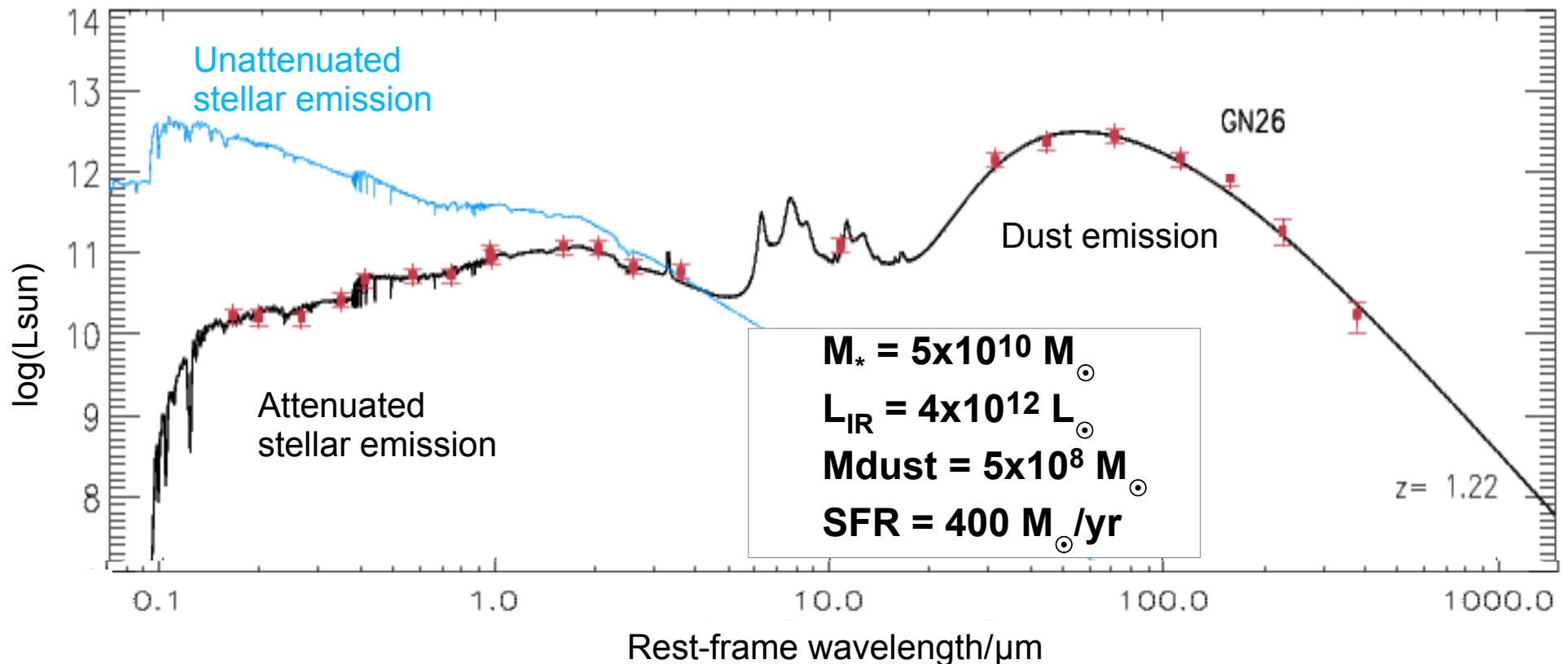
Sample selection

$>3\sigma$ at 850-1100 μm + Herschel data +
spec-z + optical-NIR imaging \rightarrow 26
sources at $z>1$. [Magnelli+12](#)

SED fitting - MAGPHYS

Optical + infrared models – stochastic SFH and different dust components

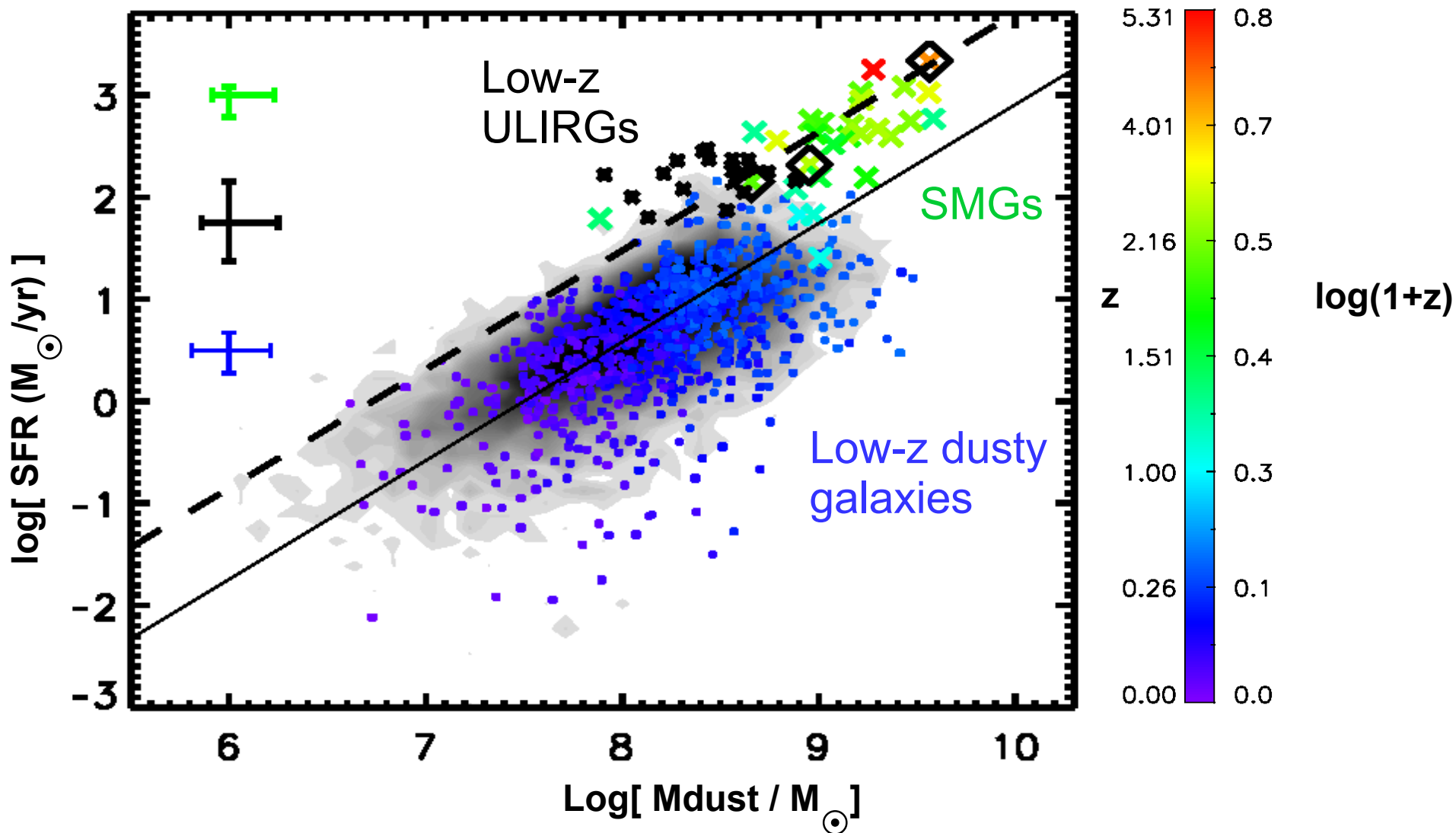
→ Balance absorbed UV energy with FIR emission



Assume: starlight absorbed by dust in birth clouds and ambient ISM is reradiated in the FIR by different dust components

da Cunha +08,10a,b

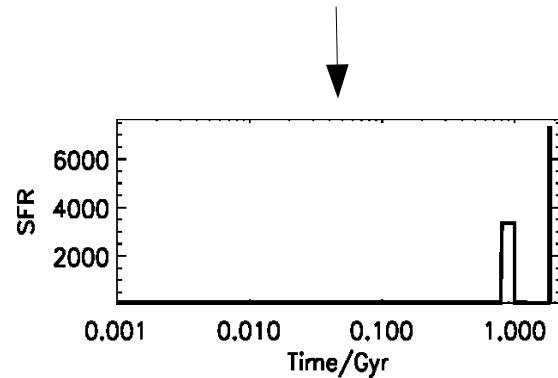
Comparing dust mass and SFR



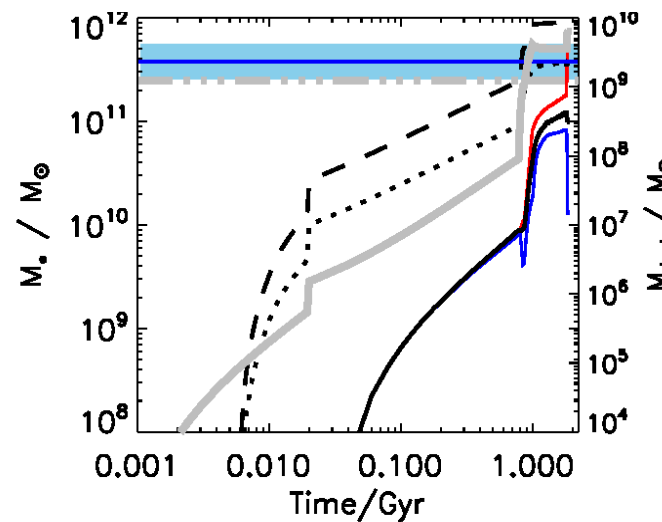
Where does dust come from?

Models take into account
lifetimes of stars
Input SFH from MAGPHYS

- + Low mass star dust
- + Supernova dust
- + Interstellar dust

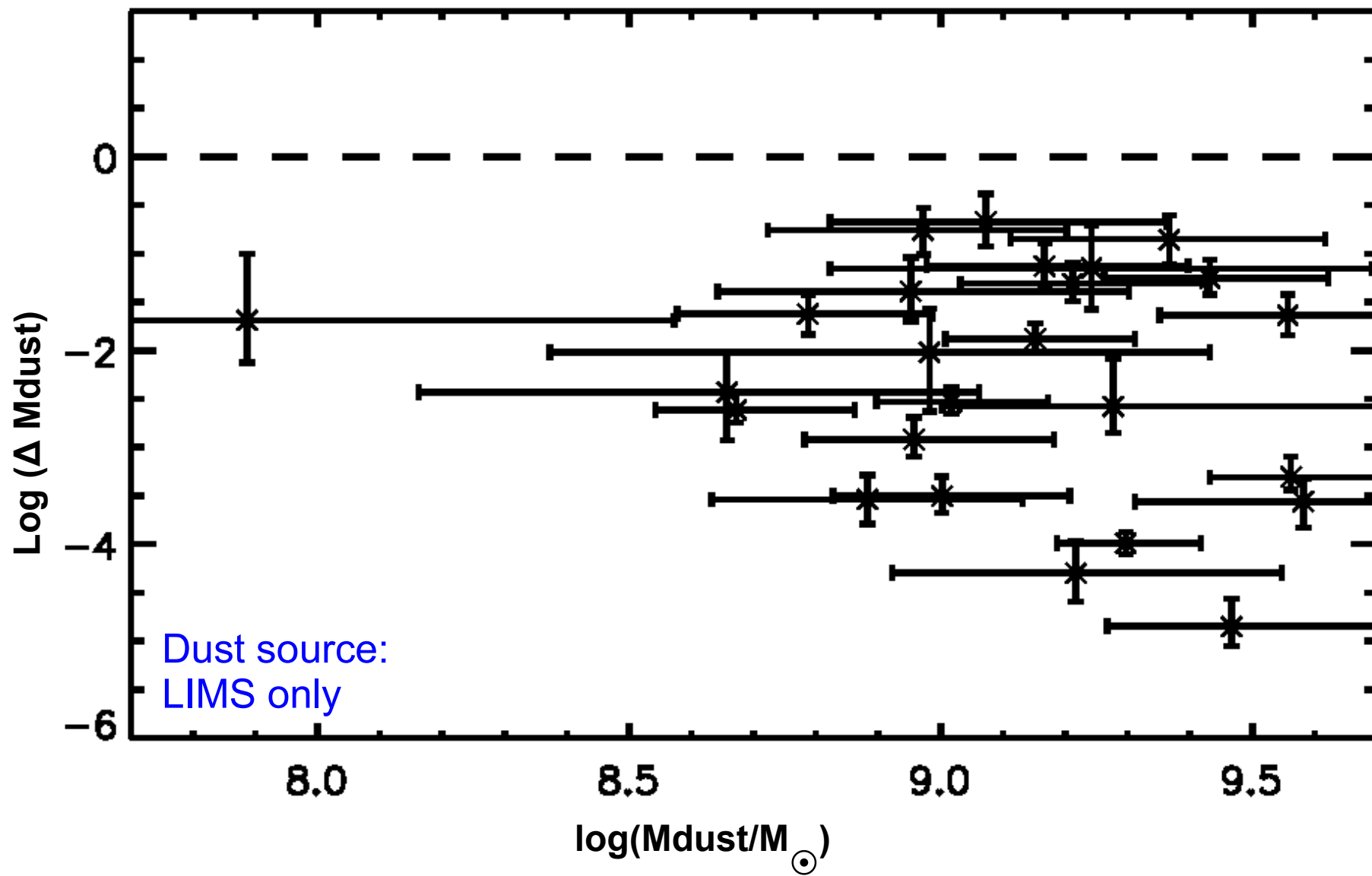


- Locked up in stars
- Supernova shocks
- Outflows

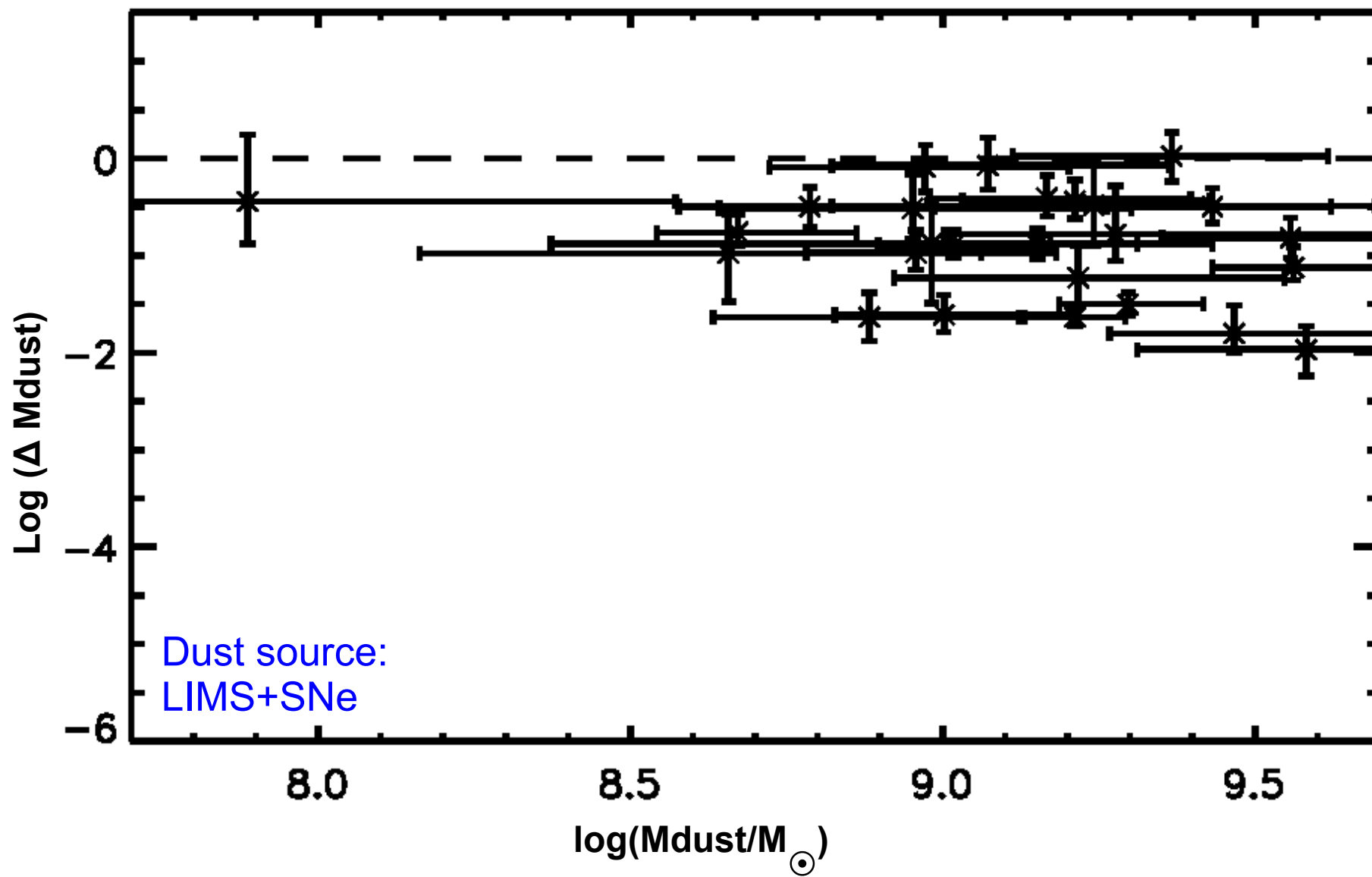


Dwek '98, Morgan &
Edmonds '03, Calura+08,
Dunne+11, Mattsson &
Andersen 12, Gomez+ in
prep

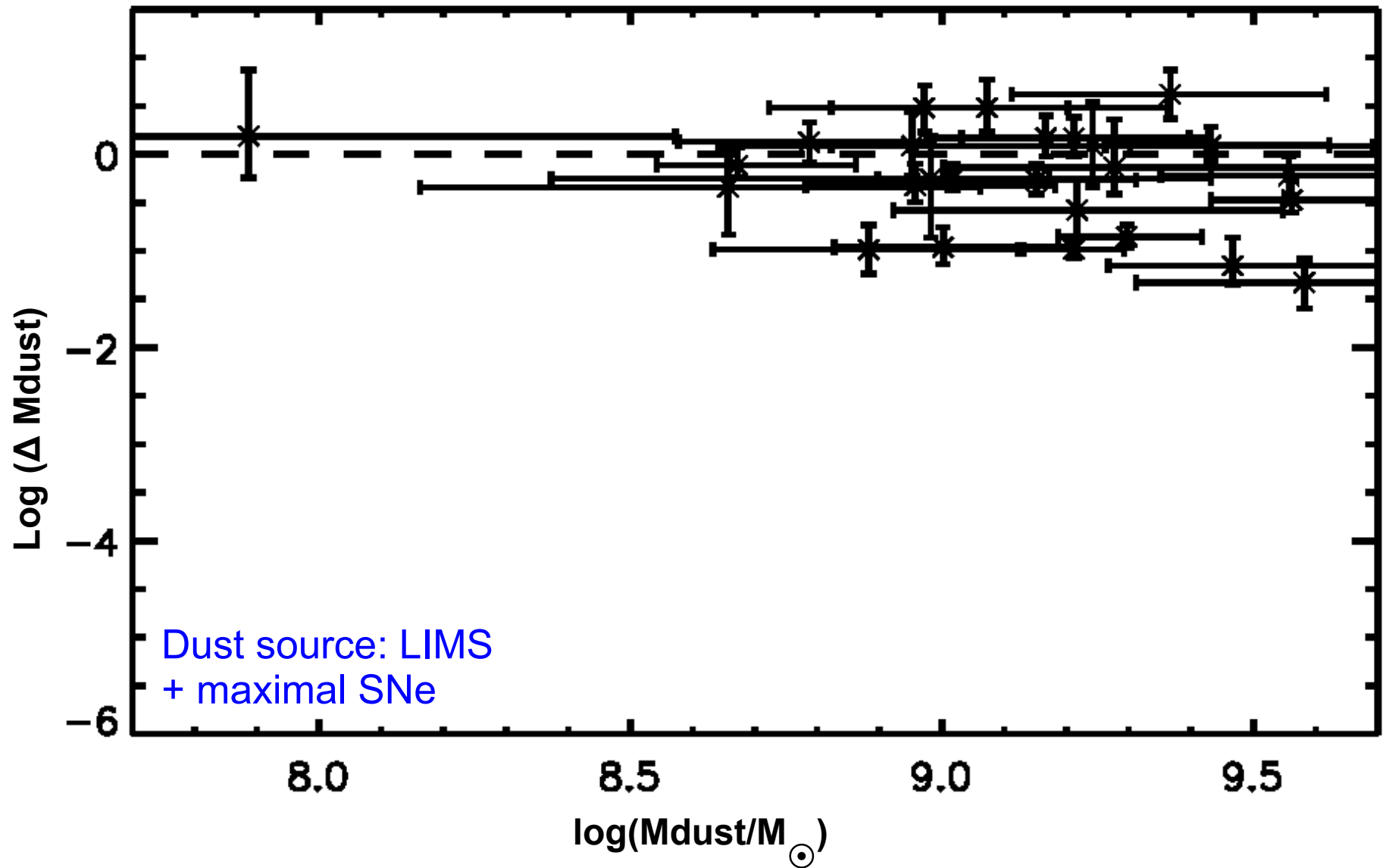
The dust budget crisis



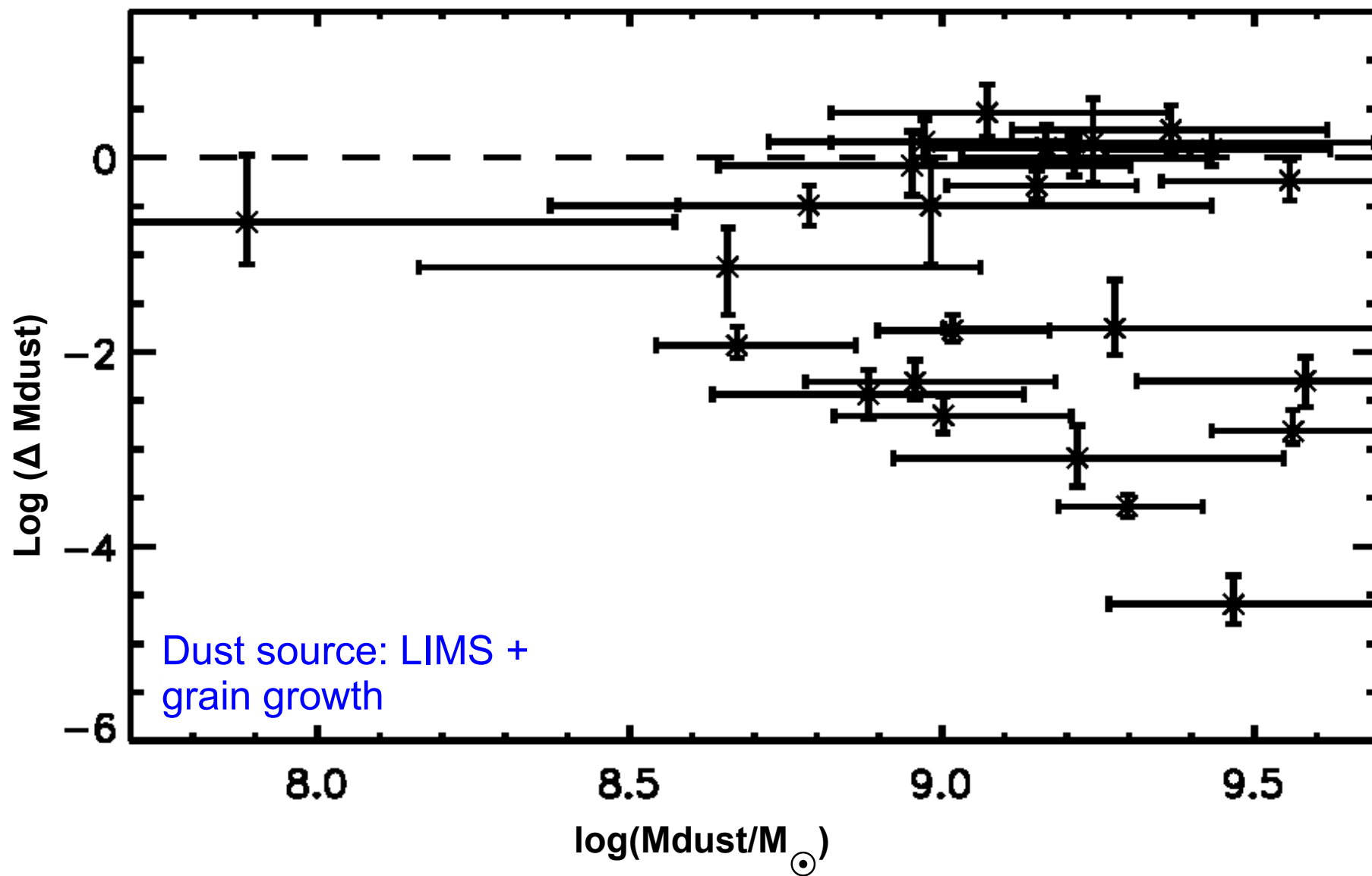
The dust budget crisis



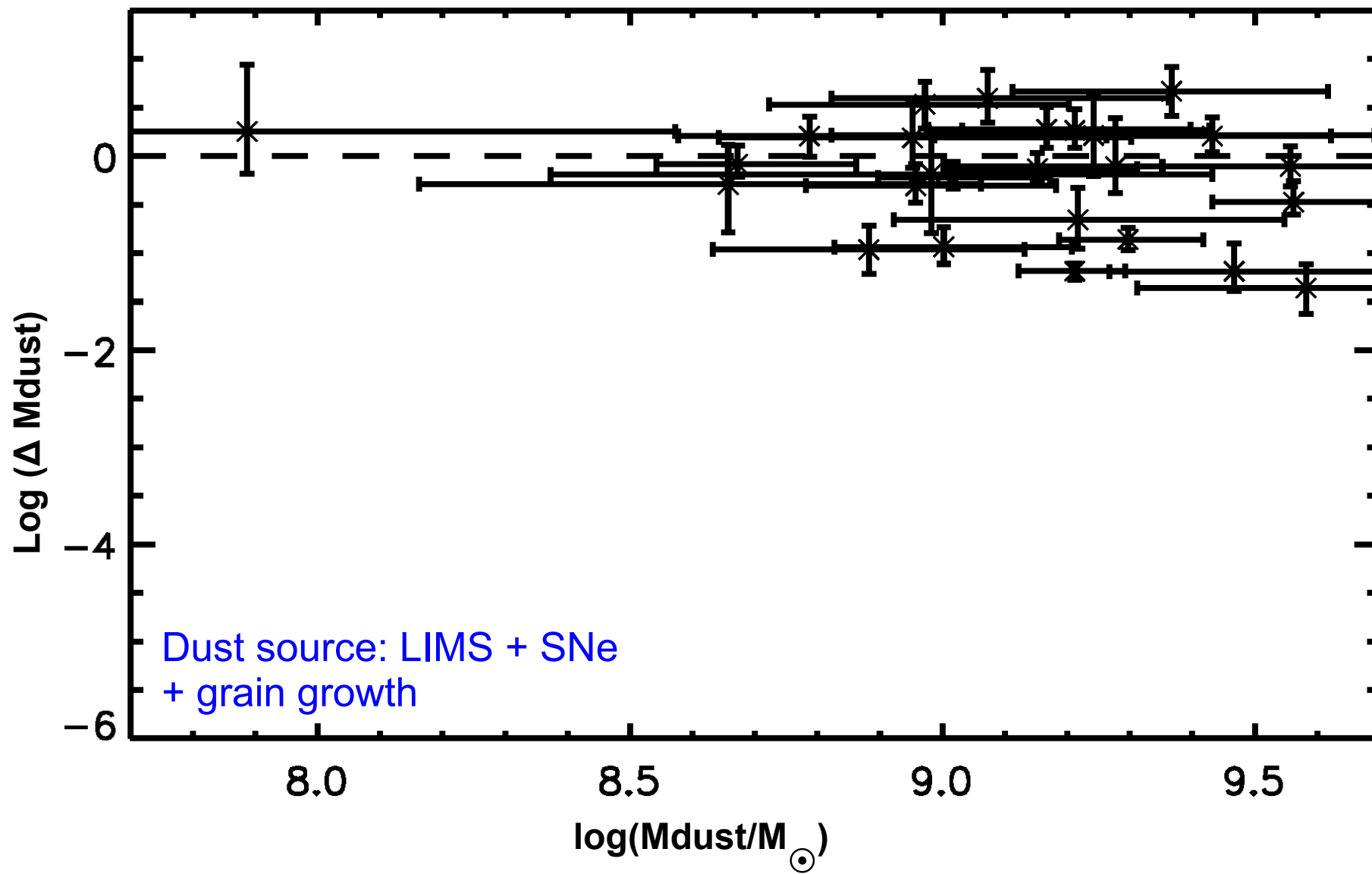
The dust budget crisis



The dust budget crisis



The dust budget crisis



Reproducing observations of SMGs

- Need rapid build-up of dust – LIMS+SNe+grain growth.
- Can accommodate a small amount of destruction if grains also produced efficiently.
- Can also accommodate inflow and outflow although lower metallicity.
- Or need top heavy IMF.
- Uncertainties in dust properties?

Conclusions

- At same dust mass SMGs are offset towards higher SFR - more efficient mode of star formation.
- Dust mass is as good a tracer of molecular gas as L'_{CO} .
- Low mass stars cannot be the only source of dust.
- Need additional source of dust – most of dust formed in ISM.
- Dust must be produced quickly and efficiently, with only a small amount destroyed by supernova shocks.