The other side of the equation

Systematic effects in the determination of dust masses

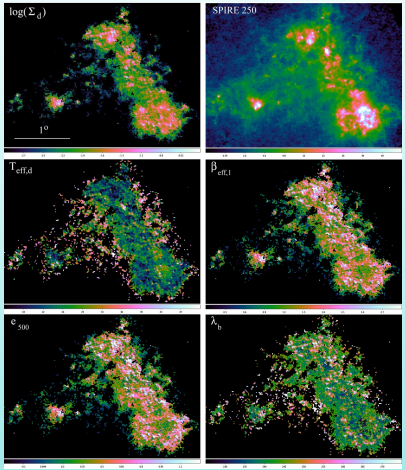
Peter Scicluna

ASIAA

JCMT Users' Meeting, Nanjing, 13th February 2017

The dust budget crisis: locally

- Measure dust masses in FIR/sub-mm
- Measure dust production in MIR



Gordon et al., 2014

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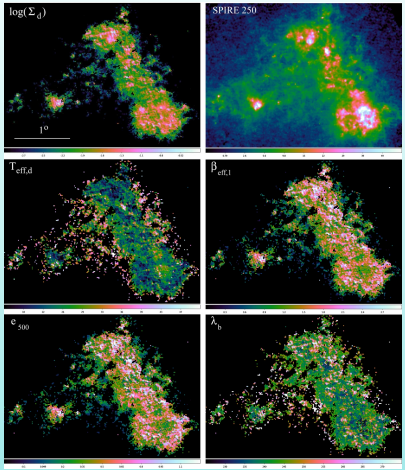
- Total dust mass $\sim$ integrated dust production over Hubble time



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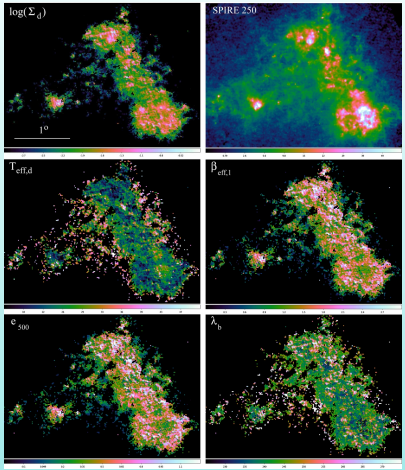
- What about dust destruction?



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The dust budget crisis: at high redshift

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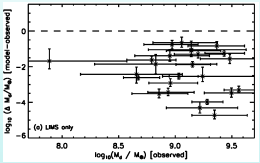
- Large dust masses exist already
- Too soon for AGB stars

Rowlands et al., 2014



The dust budget crisis: at high redshift

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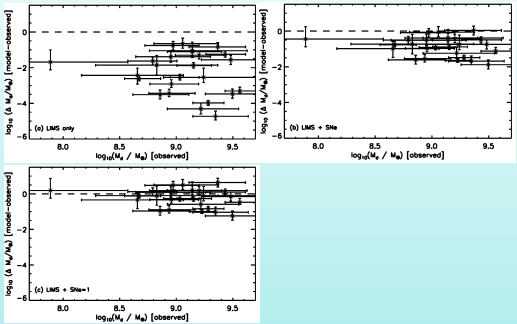
- How important are supernovae?
- Are there even enough metals yet?

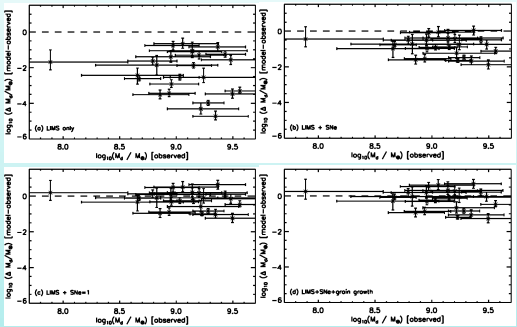
Rowlands et al., 2014



The dust budget crisis:

- Measure dust masses in FIR/sub-mm
- Dust growth in the ISM?
- Are the masses really correct?

Rowlands et al., 2014



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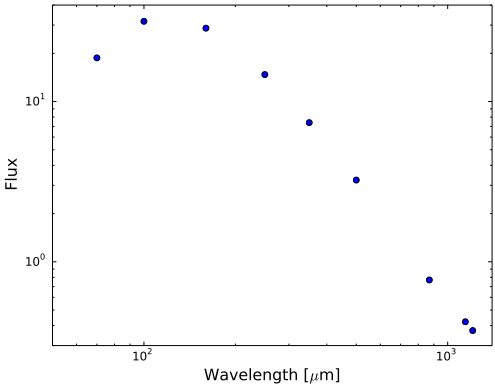

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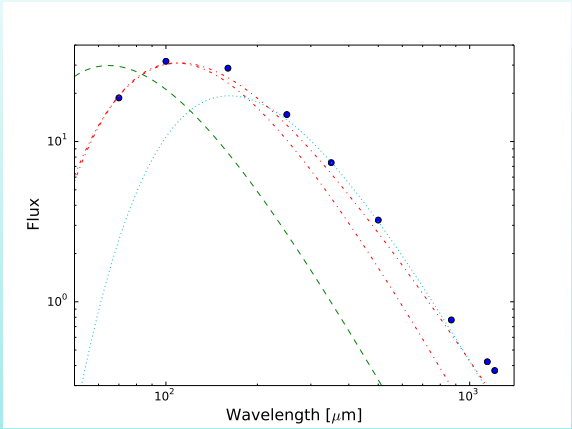

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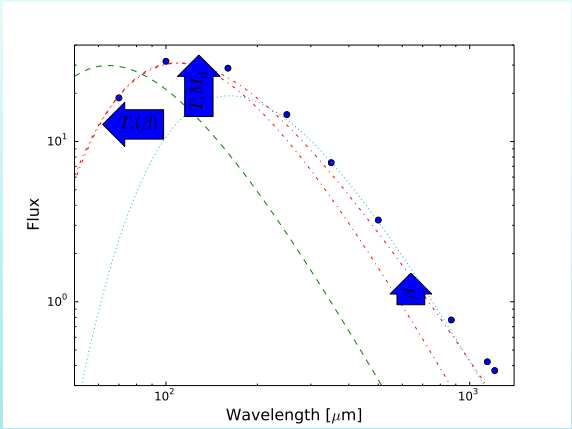

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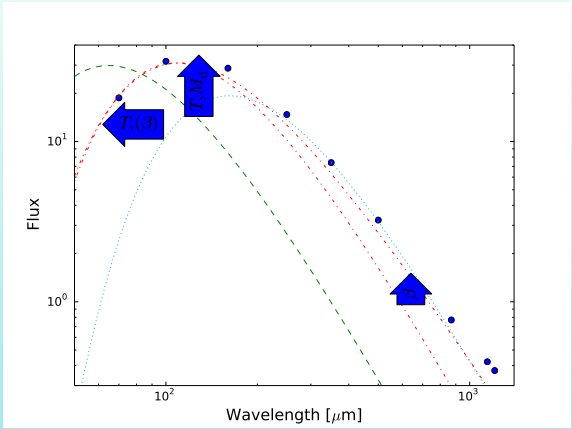

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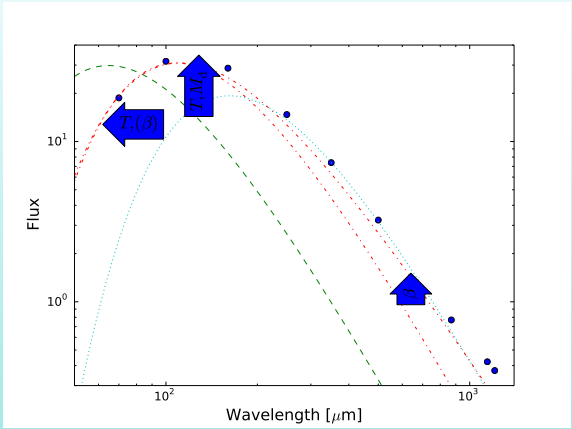

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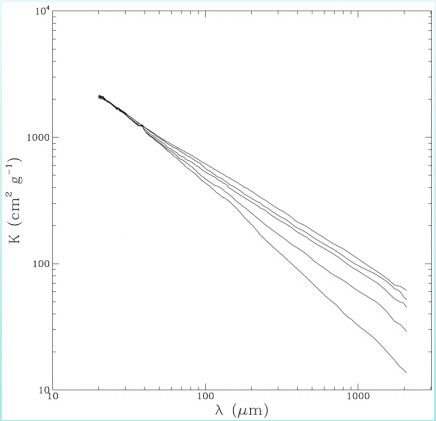

Mennella et al. (1998)

New lab measurements

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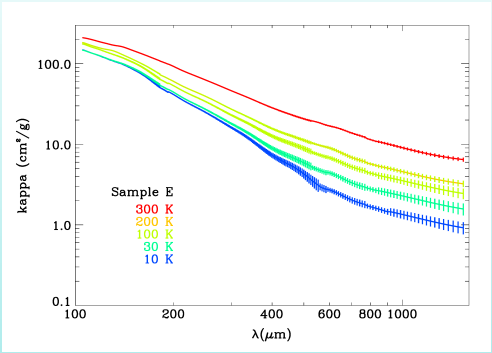
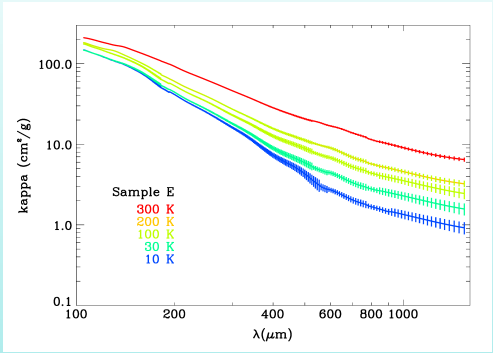
- Not just a single, simple power law



Coupeaud et al. (2011)

New lab measurements

- New measurements in FIR/sub-mm
- Depends on temperature!
- Not just a single, simple power law
- Not accounted for in current dust models!



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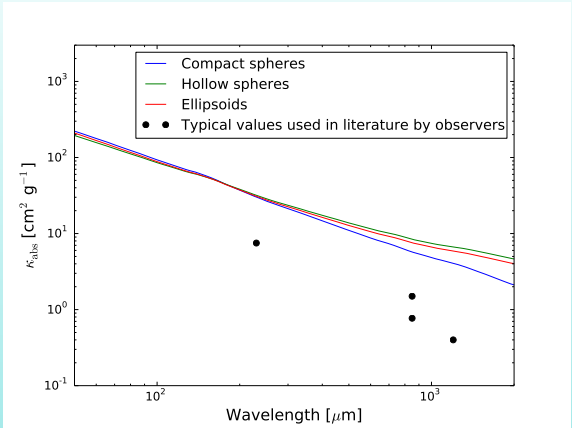

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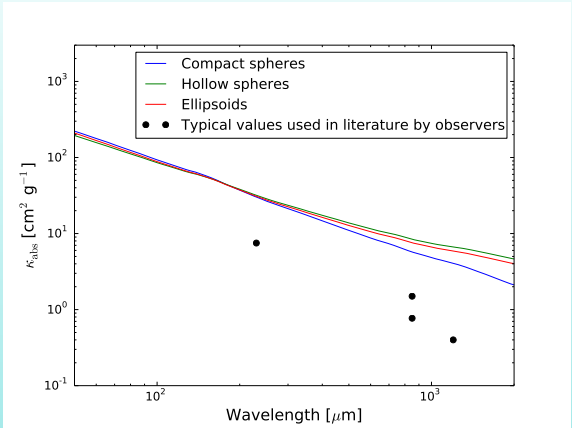

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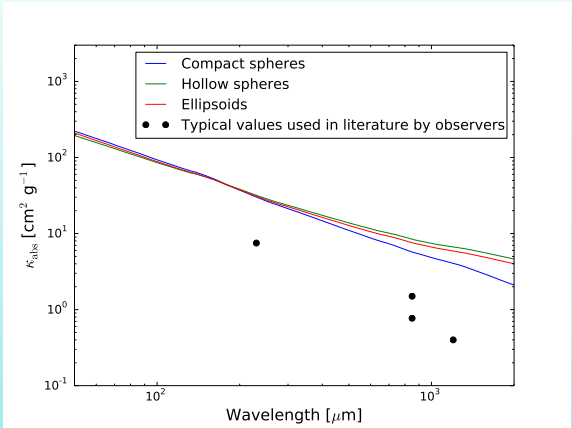

Dust models with the new lab measurements

- Temperature-dependent dust models
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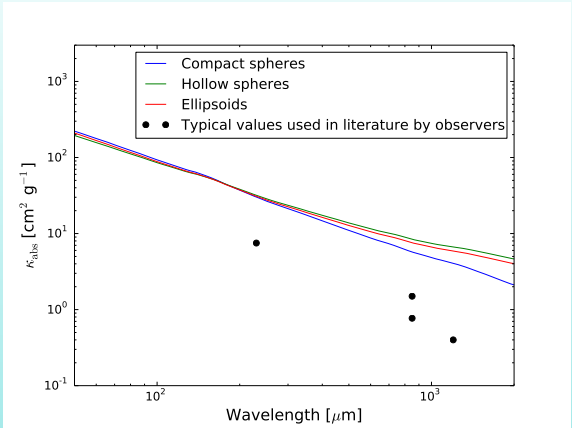
- Fraction of amC crucial
  - Can only reproduce old values with no carbon!
- short wavelengths: converge to existing models
- long wavelengths: much stronger emission!
  - $\times \sim 4$ @ 230 μm
  - $\times \sim 8$ @ 850 μm
  - $\times \sim 10$ @ 1300 μm



Implications for astronomy

- Dust masses overestimated by large fraction
- Depends strongly on fitting method, temperature and wavelength (redshift!)

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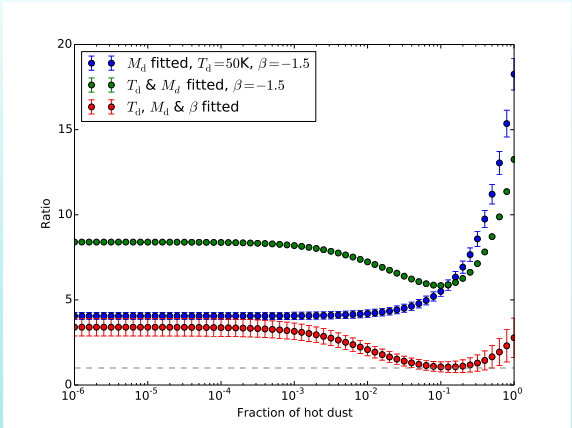
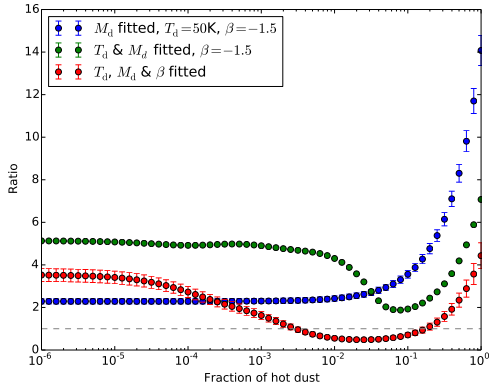


Implications for astronomy

- Dust masses overestimated by large fraction
- Depends strongly on fitting method, temperature and wavelength (redshift!)
- Slightly better at moderate redshift

z=1



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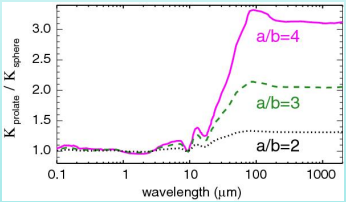
Comparison to published dust masses

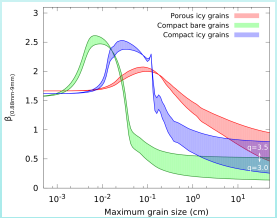
- Try computing masses from literature fluxes
  - Ignoring possible multiple T components!
- Beelen et al. (2006): 6 quasars, from z=1.8–6.5
- Using only single wavelengths, results more similar for shorter wavelengths
- Typically only $\sim 30\%$ different for $\lambda \lesssim 150\mu$m
- up to 70% for longer wavelengths!

Next steps

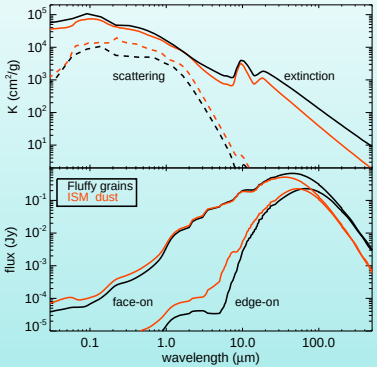
- Different/mixed compositions
- Redshift evolution
- Build model galaxies for experiments
  - role of optical depth, T, multiple dust components ?
- role of porosity? shape? size?



Siebenmorgen et al., 2014



Testi et al., 2014



Siebenmorgen et al., 2015

Summary

- Previous dust models diverge from more recent, T-dependent lab measurements
- emission up to 10 times more efficient!
- amorphous carbon fraction critical!
- Local dust budgets may be okay
- More work needed on high redshift cases
  - Proper modelling will be important