Performing detailed study of high-z IR galaxies: Galaxy-galaxy lenses in the *Herschel* HerMES survey

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with

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Gravitational lensing

- Light affected by intervening mass (galaxy).
- Flux boosted (magnified) & distorted.
- Useful for distant ULIRGs where optical reddening (& confusion) is important.
- Can study fainter objects than usually available.
- Allows gravitational studies of foreground galaxy.
Submm galaxy-galaxy lensing

Figures from Negrello et al. 2010
• $S_{500} \geq 80\text{mJy}$
• NOT local spiral in NED
• NOT radio AGN in NED

Candidate Selection

![Diagram showing the selection criteria for candidate fields. The diagram includes a graph with curves for different types of galaxies and the 500μm flux density. The red crosses indicate the selection criteria.](image)
An assortment of candidates

Keck K-band

R-band

IRAC

Subaru

IRAC

SXDFJ100.001; Ikarashi et al. 2011
Example: Lockman01
see Conley et al. 2011, Scott et al. 2011, Gavazzi et al. 2011, Riechers et al. 2011

- $S_{500} \sim 250\, \text{mJy}$
- $z_{\text{CO}} = 2.9; z_{\text{G1}} = 0.6$
- $\mu \sim 11$

![Graph showing lines and measurements](image)
Lensed galaxies are usually red in the submm
Modelling galaxy-galaxy lensing

- Consider NFW & SIS density profiles & lens “intrinsic” N(>S)
- “Intrinsic” N(>S) from Schechter function fit
- Parameters constrained by requiring fit to observed N(>S)
- $\mu > 2$ for “strong” lensing

Model will be testable with more data shortly

(thanks to Francesco De Bernardis)
high% of candidates in the model are lensed, $\mu > 2$

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Average magnification in the model is \(~5\) for HerMES candidate fluxes

\[ S_{500} \text{[mJy]} \]

\[ \text{Mean magnification} \]

=> According to the model most SMG galaxy-galaxy lenses are intrinsically “normal” SMGs

(thanks to Francesco De Bernardis)
Conclusions

- Galaxy-galaxy lens candidates are efficiently selected in wide-field submm surveys with \( \sim 0.9 \) candidates deg\(^{-2} \) at \( S_{500} > 80 \) mJy.

- Simple models of lensing with NFW or SIS profiles can reproduce observed numbers of galaxy lens candidates.

- Models suggest that 40-90\% of candidates are lensed by \( \mu > 2 \).

- Models suggest that most lensed galaxies selected by 500\( \mu \)m flux are intrinsically “normal” SMGs.

- With follow-up data, especially ALMA, we will be able to test and constrain the models.