Gravitationally lensed galaxies detected by HerMES

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Strong gravitational lensing can probe distant galaxies to depths and resolutions that would be impossible if not for the lensing amplification. We have used the wide-field coverage of *Herschel* HerMES to efficiently select strongly gravitationally lensed submillimeter galaxies, and obtained follow-up data with multiple facilities to study these galaxies (see Wardlow et al. 2013; Bussmann et al. 2013; Fu et al. 2013).

Candidate selection

- Thanks to the steep bright-end number counts (Fig. 1) strongly lensed galaxies can be simply and reliably identified by selecting bright sub-mm sources (e.g. Blain 1996; Negrello et al. 2010)
- In 95 deg^2 of HerMES there are 13 candidate lenses with S_{500}>100mJy (Wardlow et al. 2013)

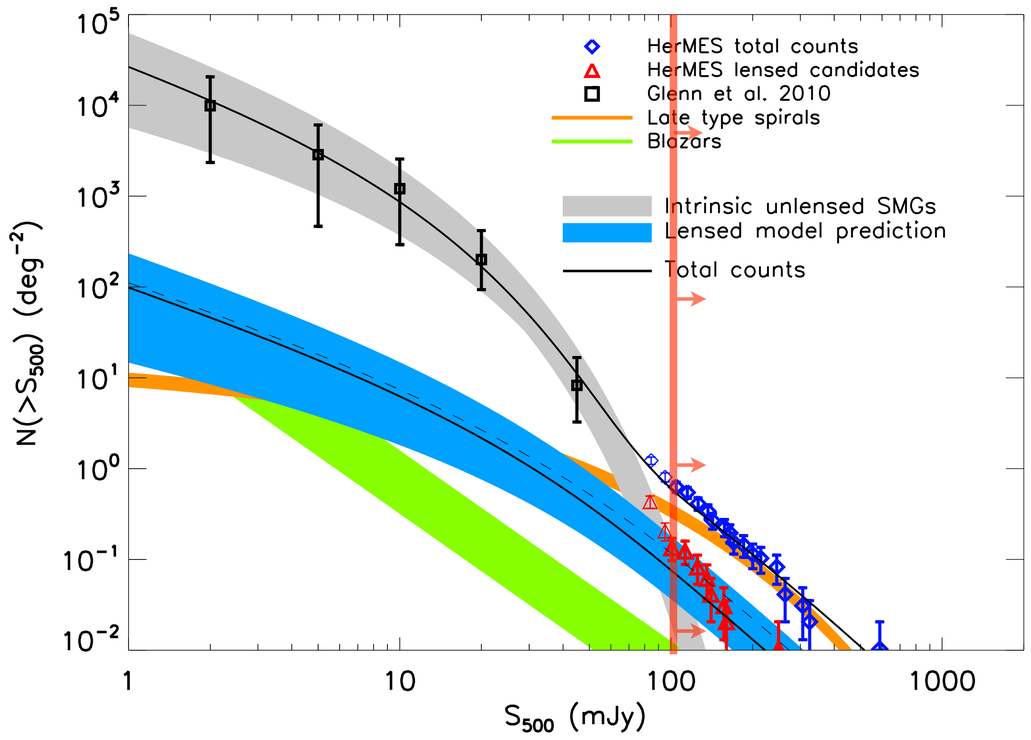


Figure 1: HerMES 500μm number counts. Our model predicts that up to ~75% of candidates with S_{500}>100mJy are lensed (Wardlow et al. 2013).

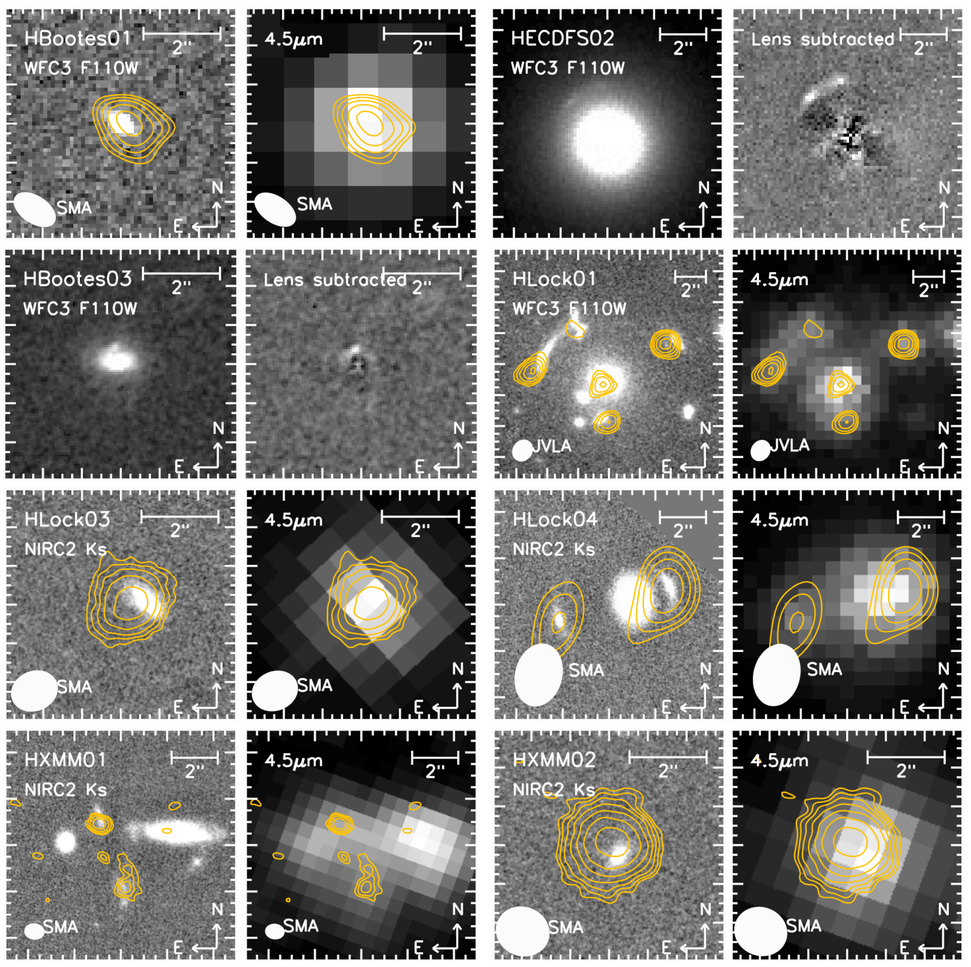
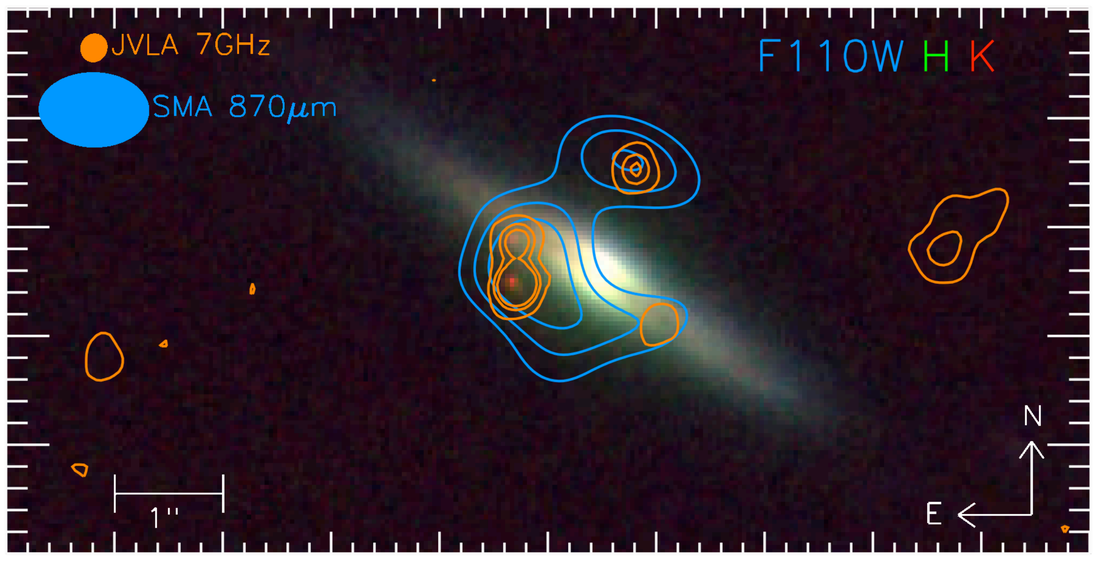


Figure 2: Follow-data for some of the lensed SMGs. The greyscale images are typically dominated by foreground lenses; contours are radio or SMA data, which trace the SMGs.

HBoötes02



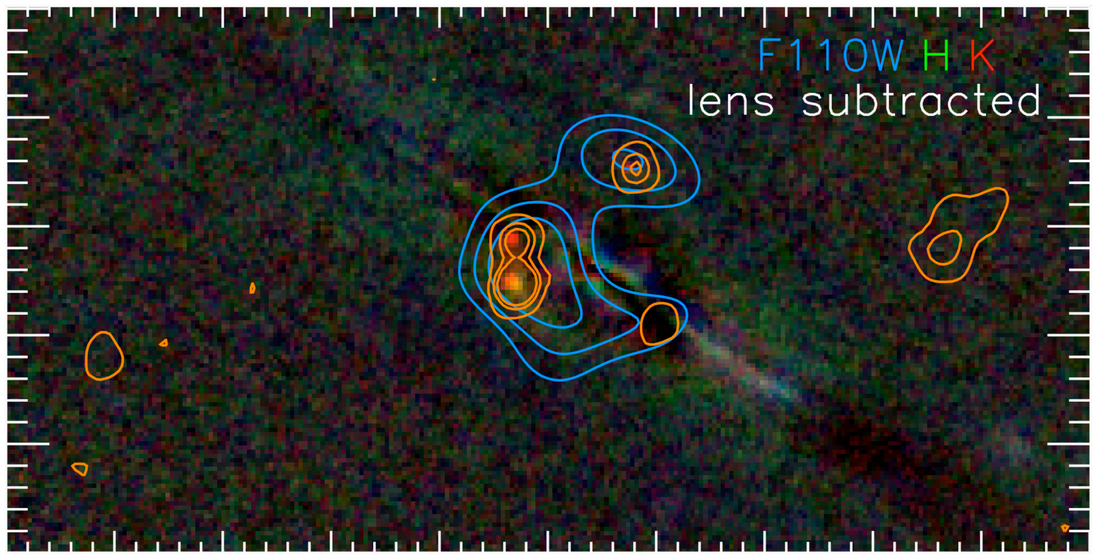


Figure 3: Keck & HST near-IR images of HBoötes02 with JVLA 7GHz and SMA 870μm contours. The SMG contains star-formation and a radio-loud AGN and is being strongly gravitationally lensed by the edge-on spiral galaxy.

- HBoötes02 is one of the HerMES lensed SMGs identified by its extreme 500μm flux (S_{500}=157±33mJy).
- The SMG (z=2.80; CO spectroscopy) is lensed by an edge-on spiral galaxy (z=0.41; optical spectroscopy).
- **Starburst:** The dust emission is extended over ~1kpc in the source plane and has an SED similar to typical z~2 SMGs: T_d~37K, β~1.5, μL_{IR}~4x10^{13}L$_\odot$, μSFR~7000M$_\odot$/yr
- **AGN:** The radio emission is ~10x brighter than expected from star-formation and unresolved to ~65pc in the source plane. There is a coincident bright X-ray source with $\mu L_{X(0.5\text{-}7keV)}$=2.1x10^{45}erg/s.
- **Differential lensing:** the radio emission is magnified by a factor of μ~23, but the sub-mm only by a factor of μ~10, due to the different emission regions in the source-plane.

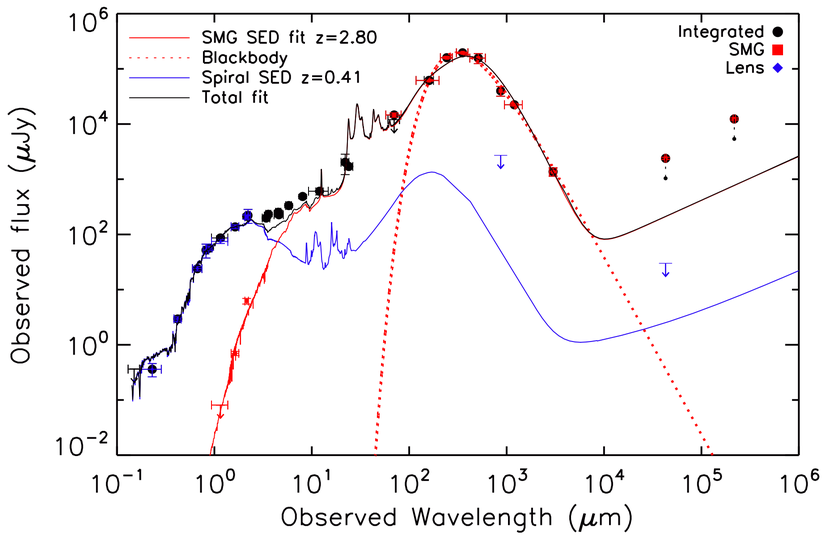


Figure 4: HBoötes02 SED, showing SMG, lens and integrated photometry. Accounting for the differential magnification (small radio symbols) does not account for the radio excess.

References

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Bussmann et al., arXiv:1309.0835
Fu et al., 2013, Nature, 498, 338
Negrello et al. 2010, Science, 330, 800
Wardlow et al. 2013, ApJ, 762, 59

Coming soon...

Calanog et al. in prep
Wardlow et al. in prep

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