Detection of an Ultra-Bright Submillimeter Galaxy in the Subaru/XMM-Newton Deep Field Using AzTEC/ASTE

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We report the detection of an extremely bright (~37 mJy at 1100 μm and ~91 mJy at 880 μm) submilli-meter galaxy (SMG), AzTEC-ASTE-SXDF1100.001 (hereafter referred to as SXDF1100.001 or Orochi), discovered in 1100 μm observations of the Subaru/XMM-Newton Deep Field using AzTEC on ASTE[1]. Subsequent CARMA 1300 μm and SMA 880 μm observations successfully pinpoint the location of Orochi (Fig. 1) and suggest that it has two components, one extended (FWHM of ~4″) and one compact (unresolved). Z-Spec on CSO has also been used to obtain a wide band spectrum from 190 to 308 GHz, although no significant emission/absorption lines are found. The derived upper limit to the line-to-continuum flux ratio is 0.1–0.3 (2σ) across the Z-Spec band.

Based on the analysis of the derived spectral energy distribution from optical to radio wavelengths of possible counterparts near the SMA/CARMA peak position, we suggest that Orochi is a lensed, optically dark SMG lying at $z \sim 3.4$ behind a foreground, optically visible (but red) galaxy at $z \sim 1.4$ (Fig. 2). The deduced apparent (i.e., no correction for magnification) infrared luminosity ($L_{\rm IR}$) and star formation rate (SFR) are $6 \times 10^{13}\,L_{\odot}$ and 11000 $M_{\odot}$ yr^{-1}, respectively, assuming that the $L_{\rm IR}$ is dominated by star formation. These values suggest that Orochi will consume its gas reservoir within a short time scale (3×10^7 yr), which is indeed comparable to those in extreme starbursts like the centres of local ULIRGs.

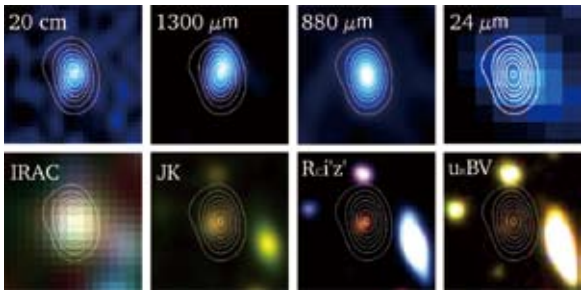

Figure 1: Multi-wavelength images of Orochi with SMA contours (3, 6, 9, 12, 15, 18, and 21 σ). The size of each image is 10″ × 10″; north is towards the top of the image and east is towards the left side of the image. From left to right and top to down: VLA 20 cm; CARMA 1300 μm; SMA 880 μm; MIPS 24 μm; rgb image of IRAC/ 3.6 μm (blue), 4.5 μm (green), 5.8 and 8 μm (red); rg image of WFCAM/ J (green) and K (red); rgb image of SuprimeCam/R, i' and z'; rgb image of SuprimeCam/u_R, B and V.

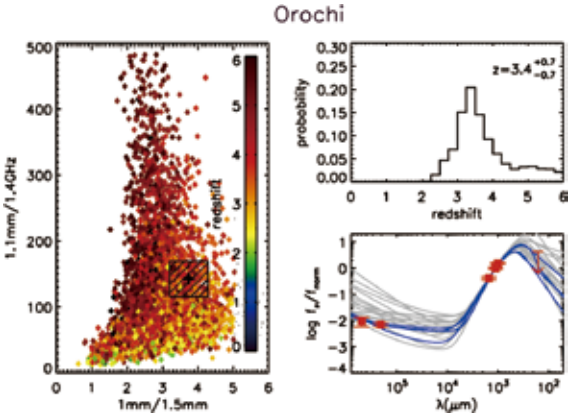

Figure 2: The left panel shows the colour-colour-redshif plot for Orochi. The flux ratios of the mock galaxies are represented as diamonds, and their redshifts are colour-coded according to the scale shown in the panel on the right. The cross represents the measured colours of Orochi, and the dashed box shows the 1σ uncertainty in each colour. The top right panel shows estimated redshift probability distribution of Orochi. In the bottom right panel, the observed SED of Orochi normalised to the flux densities at 1000 μm is shown as squares and arrows. The arrow indicates 3σ upper limits. The squares denote the detection at a level. 3σ, with 1σ error bars. The template SEDs (lines) are redshifted to z = 3.4. The template SEDs at this redshift compatible within 3σ error bars with the SED of Orochi are displayed as blue lines. The photometric data are shown at 1000, 1100, 1500 μm, 20 and 50 cm, and The upper limit is shown at 160 μm.

Reference

[1] Ikarashi, S., et al.: 2011, *MNRAS*, **415**, 3081.