A Dusty, UV-selected galaxy at $z = 7.5$

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Abstract

Candidates for the modest galaxies that formed most of the stars in the early universe, at redshifts $z > 7$, have been found in large numbers with extremely deep restframe-UV imaging. But it has proved difficult for existing NIR spectrographs to characterise them. The detailed properties of these galaxies could be measured from dust and cool gas emission at far-infrared wavelengths if the galaxies have become sufficiently enriched in dust and metals. So far, however, the most distant UV-selected galaxy detected in dust emission is only at $z = 3.2$, and recent results have cast doubt on whether dust and molecules can be found in typical galaxies at this early epoch. Here we report thermal dust emission from an archetypal early universe star-forming galaxy, A1689-zD1. We detect its stellar continuum in spectroscopy and determine its redshift to be $z = 7.5 \pm 0.2$ from a spectroscopic detection of the Lyα break. A1689-zD1 is representative of the star-forming population during reionisation, with a total star-formation rate of about $12\,\mathrm{M}_\odot\,\mathrm{yr}^{-1}$. The galaxy is highly evolved: it has a large stellar mass, and is heavily enriched in dust, with a dust-to-gas ratio close to that of the Milky Way. Dusty, evolved galaxies are thus present among the fainter star-forming population at $z > 7$, in spite of the very short time since they first appeared.