

First detection of [CII]158 μ m at high redshift: vigorous star formation in the early universe

R. Maiolino¹, P. Cox², P. Caselli¹, A. Beelen², F. Bertoldi³, M. J. Kaufman⁴, T. Nagao^{5,1}, A. Omont⁶, A. Weiss⁷, M. Walmsley¹

¹INAF-Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, I-50125 Firenze, Italy
email: maiolino@arcetri.astro.it

² Institut d'Astrophysique Spatiale, Université de Paris Sud, Orsay, France

³ Max-Planck Institut für Radioastronomie(MPIfR), Bonn, Germany

⁴ Department of Physics, San Jose State University, San Jose, CA, USA

⁵ Astronomical Institute, Graduate School of Science, Tohoku University, Sendai, Japan

⁶ Institut d'Astrophysique de Paris, CNRS, Université de Paris, Paris, France

⁷ Instituto de Radioastronomia Milimetrica, Granada, Spain

Abstract. The far infrared emission line [CII] 157.74 μ m is the strongest transition observed in most galaxies and it is an important tracer of star formation. So far this line was observed only in local galaxies. We report the *ground-based* detection of the [CII] 157.74 μ m line in the most distant quasar known, SDSSJ1148+5251 at $z=6.42$, obtained with the IRAM 30m telescope. This is the first detection of the [CII] line at high redshift, and it is also the first detection in a Hyperluminous Infrared Galaxy ($L_{\text{IR}} > 10^{13} L_{\odot}$). The $L_{\text{[CII]}}/L_{\text{FIR}}$ ratio is similar to that observed in local Ultraluminous Infrared Galaxies. The luminosity of the line confirms that the host galaxy of this quasar is undergoing an intense burst of star formation, with a star formation rate that we estimate to be of the order of 2000 $M_{\odot} \text{ yr}^{-1}$. The detection of this line suggests a significant enrichment of metals already at such early epochs (age of the universe ~ 840 Myr), although the data are not inconsistent with a reduced carbon to oxygen ratio as expected from the chemical evolutionary models in the early phases of galaxy formation. Finally, we discuss that our result casts new light on the use of this line as a powerful tool to identify and investigate star forming galaxies in submillimetric surveys at high redshift.

Keywords. galaxies: abundances - galaxies: active - galaxies: high-redshift - quasars: emission lines - quasars: individual (SDSSJ1148+5251) - galaxies: starburst - infrared: galaxies - submillimeter