CO DETECTION IN THE QUASAR BR1202–0725 AT Z = 4.69

A. OMONT
Institut d'Astrophysique de Paris, C.N.R.S.
98 bis Bd Arago
F–75014 Paris, France

P. PETITJEAN, S. GUILLOTEAU AND R.G. MCMAHON

AND

P.M. SOLOMON AND E. PECONTAL

1. Introduction

The number of identified high-redshift far-infrared hyperluminous sources ($L_{FIR} \geq 10^{13} L_{\odot}$) is now approaching ~20 (see e.g. Rowan–Robinson 1996). In about half of them, at $z > 3.5$, evidence for strong far-infrared emission has been obtained from its redshifted detection in the mm continuum. Most of the latter are bright radio-quiet QSOs (Omont et al. 1996b). The most prominent one, BR1202–0725 at z=4.7, was first detected at 1.25mm with the IRAM 30m telescope (McMahon et al. 1994) with a flux of ~ 10–15 mJy. Its submm detection at JCMT (Isaak et al. 1994) supports dust emission because of a submm–mm spectral index ≥ 3.

The far-infrared emission of nearby ultraluminous IRAS galaxies is believed to be related at least partially to intensive star formation. The presence of a strong amplification by gravitational lensing has allowed the detection and detailed studies of CO emission in two high redshift sources at z ~2.5, FIRAS10214+4724 and H1413+117 (Brown & VandenBout 1992, Solomon et al. 1992, Barvainis et al. 1994, Barvainis 1996, Scoville 1996). The presence of a strong starburst activity is thus well proven there.

2. Results

The search for CO in the radioquiet QSOs at $z > 4$ detected in the mm continuum is particularly important to confirm the presence of an extreme starburst generating a large amount of metals at such a redshift. We report

E. F. van Dishoeck (ed.), Molecules in Astrophysics: Probes and Processes, 501–503.

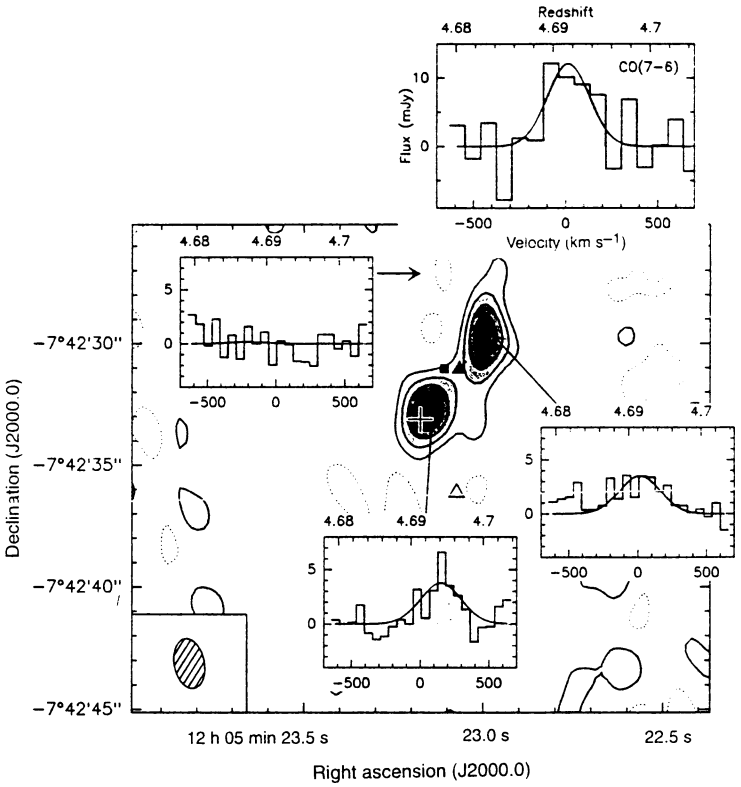


Figure 1. Spectra of the CO J=5–4 line emission (histogram in small boxes) superposed on the 1.35 mm continuum image obtained with the IRAM Plateau de Bure interferometer. Arrows show the location of the emitting region for each spectrum. The large box at the top shows the spectrum of the CO J=7–6 line observed with the IRAM 30m telescope (from Omont et al. 1996a).

here a summary of our detection of CO in BR1202–0725 (Omont et al. 1996a). A similar detection is independently reported by Ohta et al. (1996). Observations were simultaneously performed in the 3mm and 1.3mm bands with the IRAM interferometer. The map in the continuum emission at 1.3mm shows that it is extended with two prominent peaks; one at the QSO position, the other 4″ away in the North–West direction.

The CO J=5–4 line, at 101.3 GHz, is detected towards both positions with comparable intensities (see Figure 1). Each of these lines is detected at $\sim$(5–6)σ level. As both detections are independent, CO(5–4) emission is definitely detected at about the 8σ level. The linewidths, $\sim$ 200–300 km s^{-1}, are in the range observed for other ultraluminous infrared galaxies. The redshifts of the CO lines at the two positions are similar within $\sim$

https://doi.org/10.1017/S0074180900009657 Published online by Cambridge University Press

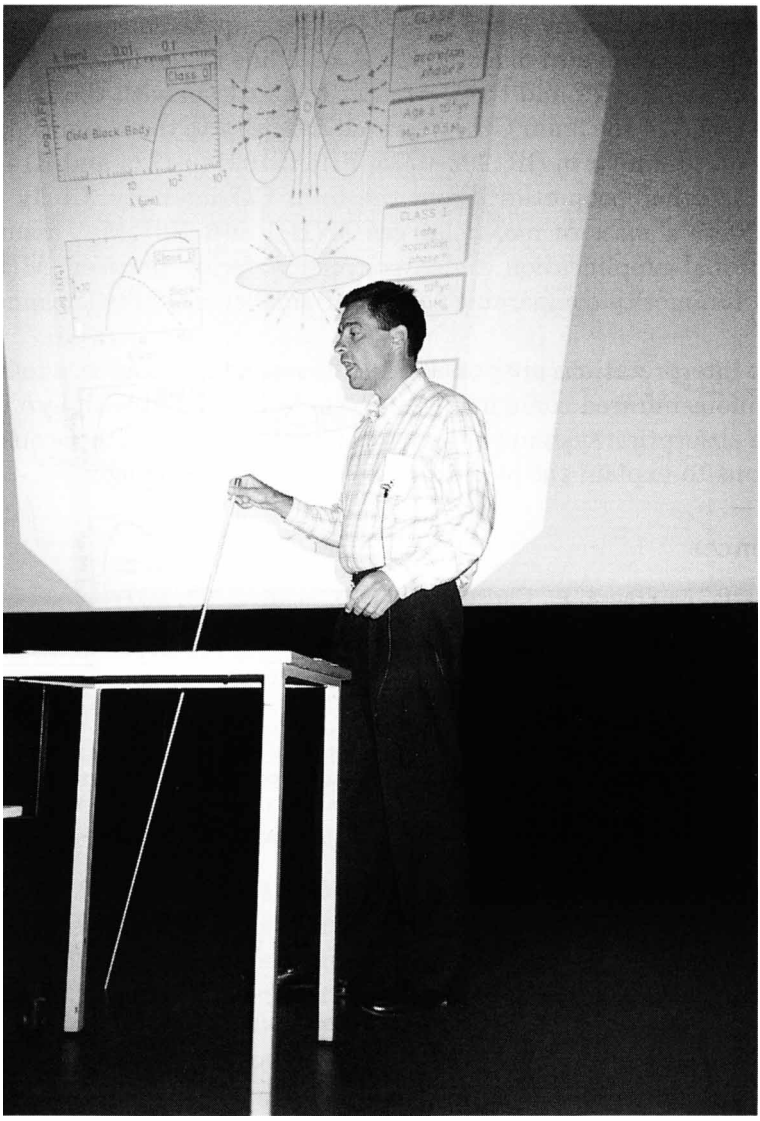
200 km s^{-1}. Both are within a few hundred km s^{-1} of the redshifts of a metallic absorption system and of the companion Lyα emission detected by Petitjean et al. (1996) and Hu et al. (1996) at a position $\sim 2''$ NW of the QSO, midway of the two millimeter peaks.
The results obtained by Ohta et al. (1996) are quite consistent with ours. In addition we have also detected the J=4–3 line at the 5–6σ level with the IRAM interferometer and the J=7–6 at the 3σ level with the IRAM 30m.

The ratios of the 3mm CO integrated intensity to the 1.3mm continuum flux are quite similar in BR1202–0725, FIRAS10214+4724 and H1413+117, as well as other properties. From the total CO intensity 3.1 Jy km s^{-1}, one deduces a mass of molecular gas $M(H_2) \sim 6\ 10^{10}\ M_\odot$, assuming no gravitational amplification and a conversion factor between $M(H_2)$ and the CO luminosity comparable to that at smaller redshifts (Solomon et al. 1992).

Two interpretations are possible for the second mm source: a massive hyperluminous infrared companion which could be related with Lyα emission and the absorption system ; or a gravitational lens with rather constraining conditions to explain the absence of a second optical image.

References

Andreani, P., La Franca, F., Christiani, S. 1993, MNRAS 261, L35
Barvainis, R., Tacconi, L., Antonucci, R., Alloin, D., Coleman, P. 1994, Nature 371, 586
Barvainis, R. 1996, in *Cold Gas at High Redshift*, eds. M. Bremer, H. Röttgering, P. van der Werf & C. Carilli (Kluwer, Dordrecht), p. 301
Brown, R.L., Van den Bout, P.A. 1992, ApJ 397, L9
Hu, E.M., McMahon, R.G., Egami, E. 1996, ApJ 459, L53
Isaak, K.G., McMahon, R.G., Hills, R.E., Withington, S. 1994, MNRAS 269, L28
McMahon, R.G., Omont, A., Bergeron, J., Kreysa, E., Haslam, C.G.T. 1994, MNRAS 267, L9
Ohta, K., Yamada, T., Nakanishi, K., Kohno, K., Akiyama, M., Kawabe, R. 1996a, Nature 382, 428
Omont, A., Petitjean, P., Guilloteau, S., McMahon, R.G., Solomon, P.M., Pécontal E. 1996a, Nature 382, 428
Omont, A., McMahon, R.G., Cox, P., Kreysa, E., Bergeron, J., Pajot, F., Storrie–Lombardi, L.J. 1996b, A&A 315, 1
Petitjean, P., Pécontal, E., Valls–Gabaud, D., Charlot, S. 1996, Nature 380, 411
Rowan–Robinson, M. 1996, in *Cold Gas at High Redshift*, eds. M. Bremer, H. Röttgering, P. van der Werf & C. Carilli (Kluwer, Dordrecht), p. 61
Scoville, N.Z. 1996, in *Cold Gas at High Redshift*, eds. M. Bremer, H. Röttgering, P. van der Werf & C. Carilli (Kluwer, Dordrecht), p. 25
Solomon, P.M., Downes, D., Radford, S.J.E. 1992, ApJ 398, L29



https://doi.org/10.1017/S0074180900009657 Published online by Cambridge University Press