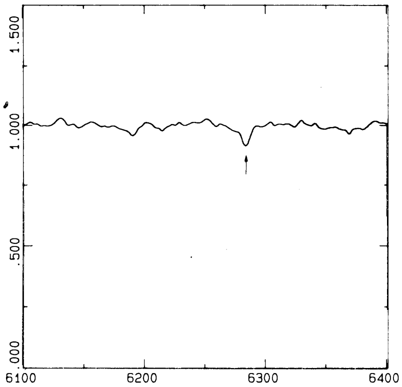

Figure 3: *6100–6400 Å spectrum. The position of the feature at 6284 Å is marked.*

telluric features; this is important for the DIB at 6284 Å which is affected by an O_2 atmospheric band. Grating No. 21 was used in the range 3860–6690 Å. The spectral resolution was ~7 Å (FWHM). The strongest certain DIBs [3] were searched for in the ratioed spectrum. In this spectrum, the DIB at 4430 (Fig. 1), 5780 (Fig. 2) and 6284 Å (Fig. 3) are clearly detected, but not the one at 5797 Å (Fig. 2).

The presence of DIB carriers in a carbon star CDS is of importance. It suggests that at least some of them are carbon-rich and gives support to the hypothesis that some type of PAHs are responsible agents. If PAHs are indeed DIB carriers, it means that the carbon star CDSs are among the sites of formation of PAHs; carbon-rich planetary nebulae were already known as sites of formation of PAHs (see for instance [4]). The ratio of the equivalent widths of 5780 to 5797 Å is ~2 in the interstellar medium [3]; the non-detection of 5797 Å in the CS776 companion spectrum gives support to the principle of dividing DIBs into families [5]. A recent work carried out at ESO [6] shows that the DIB carriers and the 2175 Å feature carriers (most probably small graphite grains) do not share the same origin. The presence of DIB carriers around CS776 suggests that graphite grains or their progenitors are not formed there, and lets little room for the existence of pure-carbon dust in carbon-rich CDSs. It is worth to remind that, around carbon stars, there is unambiguous observational evidence of *only* SiC and MgS grains.

Finally, most studies of DIBs are made at high-spectral resolution (R > 10,000). This is required if one wants to separate the components due to several intervening clouds but limits the sample of observable objects to bright ones and the sample of DIBs to narrow ones. However, the mere detection of DIBs does not necessitate such spectral resolution and the advantages of working at a lower resolution (~1000) are obvious.

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PHL 1222: an Interacting Quasar Pair?

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The "By-Product" of a Survey

The origin of quasars and Active Galactic Nuclei (AGN) is one of the outstanding problems of modern extragalactic astronomy. Mergers and gravitational interactions between galaxies are probably more frequent at large redshifts, and may lead to the appearance of quasars and other AGN. As a matter of fact, there is now an increasing body of evidence – from observations and computer simulations – that gravitational interactions between galaxies may be somehow responsible for the onset and fueling of the nuclear activity (e.g., Hernquist 1989, and references therein).

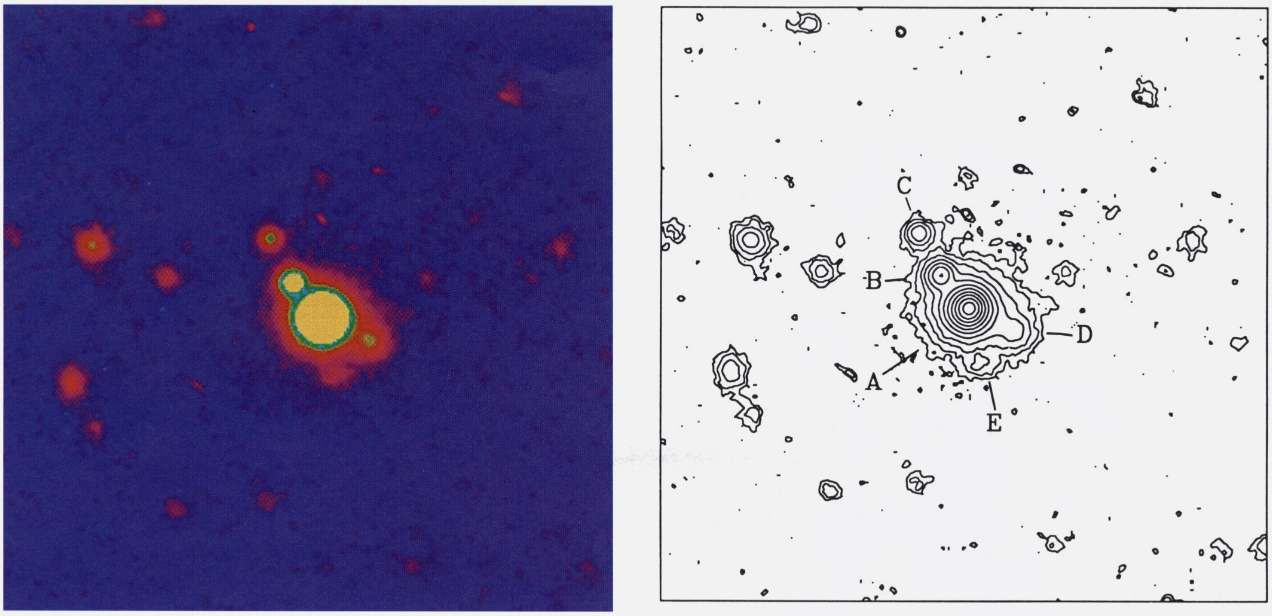
Three close pairs of quasars or AGN at large redshifts have been discovered recently: PKS 1614+051, QSO + AGN, at z = 3.215 (Djorgovski et al. 1985, 1987a), PKS 1145–071, QSO + QSO, at z = 1.345 (Djorgovski et al. 1987b), and QQ 1343+266, QSO + QSO, at z = 2.030 (Crampton and Cowley 1987). In these three systems we may be witnessing the triggering events responsible for the nonthermal activity in both objects, i.e., the birth of pairs of AGN at redshifts where the comoving density of quasars was close to its maximum. Their further study, and discoveries of more such systems, can help us to better understand the processes responsible for the origin and maintenance of nonthermal activity in the cores of galaxies.

We report here the discovery of a close pair of quasars, possibly the most interesting system of its kind, known as PHL 1222 = UM 144 = QSO 0151+048. It is composed of a close physical pair of QSOs with similar redshifts, $z \simeq 1.91$, and separated by 3.3 arcsec (Meylan et al. 1989, 1990).

The discovery of such pairs of quasars is the by-product of a survey for gravitationally lensed quasars. We are conducting such an optical imaging survey, with a spectroscopic follow-up for the promising cases. A sample of known QSOs has been selected on the basis of apparently large absolute luminosities and high redshifts. So far, this survey has yielded one close pair of possibly interacting quasars, PKS 1145-071 (Djorgovski et al. 1987b), one very probable gravitational lens, UM 425 (Meylan and Djorgovski 1989), several other promising lens candidates, and several cases of foreground or associated galaxies within a few arcsec from the quasars (Djorgovski and Meylan 1989, and Meylan et al. 1990). Our survey has now merged into the ESO Key Programme for Gravitational Lensing (Surdej et al. 1989).

PHL 1222: the Initial Observations

The quasar PHL 1222 = UM 144 = QSO 0151+048 (Burbidge 1968) is one



Figures 1a and 1b: *Figure 1a contains a false-colour image of the PHL 1222 system and Figure 1b displays the corresponding contour map. Both figures come from the same stack of CCD VR frames obtained at La Silla with the 2.2-m telescope, with a total integration time of 4.5 hours. The field shown is 45 × 45 arcsec, with north at the top and east at the left. The components of the PHL 1222 system are indicated with letters on the right image.*

of the objects selected as potential lens candidates on the basis of the two criteria mentioned above. The first piece of evidence of the multiple character of PHL 1222 is found in the multicolour CCD frames obtained with the 40-inch telescope at Las Campanas Observatory (Chile) on UT 1988 October 21. These images show at least one close companion (which we denote as B), with the same colours (within the errors) as the bright QSO itself (denoted as A).

The confirmation of the interesting character of PHL 1222 is provided by observations taken at the ESO La Silla observatory. Spectra of both components A and B were obtained with the ESO Faint Object and Spectrograph Camera (EFOSC) at the ESO 3.6-m telescope, on the nights of UT 1988 December 8, 9, and 10. Some deep imaging frames were obtained with a high resolution CCD camera at the ESO/PMI 2.2-m telescope, on the nights of UT 1988 December 11, 12, and 13. Subsequent images and spectra were obtained at Palomar Observatory using the 200-inch Hale telescope and the 4-Shooter imager/spectrograph, on the nights of UT 1989 September 6 und 7.

False-colour image and contour map of the system are shown in Figures 1a and 1b, respectively. Both come from the same stack of CCD VR frames obtained at La Silla with the 2.2-m telescope. The total integration time amounts to 4.5 hours. The field shown is 45 × 45 arcsec, with north at the top and east at the left. The isophotal levels are spaced logarithmically in factors of 2. The components of the PHL 1222 system are indicated with letters: the companions labelled B, C, D, and E, in decreasing brightness, encircle the bright image of the quasar A. The separation between the quasar image A (V = 17.6 mag) and its brightest companion B (V = 21.25 mag) is 3.3 arcsec. The differences in BVR magnitudes between A and B components are almost constant, $\Delta m \sim 3.55$, but from the colour indices, companion B seems slightly bluer than the quasar A. Object C, at 6.8 arcsec from A, is unresolved and redder than A or B. Objects D and E are both resolved, at about 4 arcsec from A; they are very blue in colour.

PHL 1222: a Gravitational Lens or an Interacting Quasar Pair?

The spectra of the two components A and B (with a total exposure time of 3 hours in each B300 and R300 grism) immediately confirmed that both objects are quasars, with the same emission lines (viz., C IV 1549, C III] 1909, and Mg II 2799) at about the same redshift, $z \simeq 1.91$. Differences in velocity between the two spectra have been obtained from emission line redshifts ($\Delta V = 1380 \pm 240$ km s^{-1}) and from cross-correlation ($\Delta V = 520 \pm 160$ km s^{-1}). These ΔV values are typical of velocity dispersion in clusters of galaxies. The relative intensities of the C IV 1549 and C III] 1909 lines are reversed in the spectra of A and B. While the continuum of the faint quasar B is nearly flat, the continuum of the bright quasar A increases significantly from the blue to the red, so much as to have a flux level twice as high in the red than in the blue (thus the bluer B-V colour index of component B). Additionally, the equivalent widths of the emission lines are much larger for the fainter component B. All these dissimilarities in the shapes of the emission lines and the continuum, as well as the differences in redshift, favour the interpretation of PHL 1222 as being a physical quasar pair rather than a gravitational lens.

Component C of the system (see Figure 1), very red in colour, has been weakly detected in the R300 grism spectra. The very low S/N ratio hampers any clear determination of the nature of this object. It could be a foreground galaxy at $z \sim 0.8$ if we interpret the increase in intensity towards the red as the break at 4000 Å. It may also be a foreground galactic star, possibly an M dwarf. The nature of the remaining companions is still unknown. It is possible that we are seeing a compact group or a cluster core still in the process of formation. Further studies of this system are likely to be highly rewarding.

In spite of a few attempts about ten years ago, PHL 1222 has not been detected in radio. Sramek and Weedman (1980) summarize the flux density limits obtained so far: 20 mJy at 1415 MHz, 18.3 mJy at 2380 MHz, and 2.3 mJy at 4885 MHz. We are unaware of any other radio observations of this system.

PHL 1222: a Tentative Estimate of the Total Mass of the System

Under the assumption that the two QSOs are gravitationally bound, and that there is no other massive object in their vicinity, their projected separation and their velocity difference allow us to place a lower limit to the total mass of the system by using the Virial mass equation. At z = 1.91, with H_0 = 75 km/s/Mpc and Ω_0 = 0, 3.3 arcsec correspond to 28 kpc, whereas with Ω_0 = 1, 3.3 arcsec correspond to 18 kpc. Considering a minimum separation of about 20 Kpc and a minimum velocity ΔV = 500 km s^{-1}, the (minimum) virial mass amounts to about $M_A + M_B \simeq 1.7 \times 10^{11}$ $M_\odot$, a reasonable value for normal galaxies. Allowance for projection effects would suggest a true value of the total mass of the system several times larger than that.

PHL 1222: a Possible Interaction Event

Recent numerical simulations show that gas distributed throughout a galaxy responds strongly to the tidal field of a close companion. In some cases, dynamical instability drives a large fraction of the gas into the inner regions of the galaxy (Hernquist 1989). A strong burst of star formation may follow and subsequent evolution may lead to the formation of a black hole. Continued accretion of gas by the black hole may provide enough power to explain quasars and nuclear activity. From an observational point of view, the "interaction model" seems also to be the dominating paradigm for explaining the origin of nuclear activity in galaxies (cf. Fricke and Kollatschny 1989 for a recent review and further references).

Most interestingly, PHL 1222 was already known to have an absorption system with $z_{abs} > z_{em}$, which almost coincides with the redshift of the fainter component B. This absorption may be a signature of the ambient gas in a probably interacting system. The coincidence between the binary character of PHL 1222 and its $z_{abs} > z_{em}$ absorption system raises an important question: do the other quasars showing $z_{abs} \simeq z_{em}$ also have close neighbours? For example, there is substantial associated Mg II 2799 absorption in component B of the PKS 1145-071 system (Djorgovski et al., in preparation).

Many quasars with $z_{abs} \simeq z_{em}$ have been intensively studied spectroscopically, but not by deep and/or high-resolution imaging (Foltz et al. 1988). It is possible that more interacting systems can be found by imaging quasars with $z_{abs} \simeq z_{em}$. We have already obtained 4 nights at the 3.5-m NTT telescope, which will hopefuly begin to answer this question.

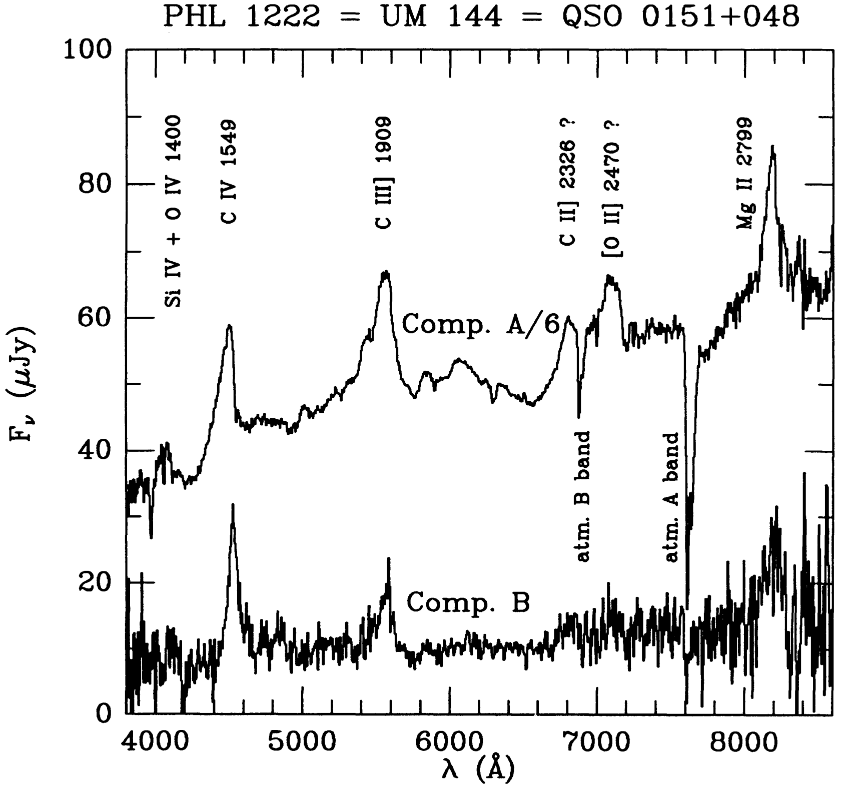


Figure 2: *CCD spectra of components A and B, obtained at ESO, indicating that both objects are quasars. The spectrum of the brighter component A is scaled down by a factor of 6 for easier comparison. The two spectra show some dissimilarities in redshifts, in the shapes of the emission lines (viz., C IV 1549, C III] 1909, and Mg II 2799) and in the continuum, which favour the interpretation of PHL 1222 as being a physical pair of quasars rather than a gravitational lens.*

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ADDENDUM

Narrow Band Imaging of M87 with the NTT by B. JARVIS, ESO
(*The Messenger* **58,** 10)

The first reported observation of the H_α + [N II] features in M87 was by Arp (1967) who observed the filamentary feature SE of the nucleus. This was followed by Walker (1968) who discovered a "fan-shaped emission jet" in the light of [O II] Å 3726-29. Ford and Butcher (1979) published ISIT video camera images showing that the H_α + (N II] structure extended to the NE and into the core, van den Bergh (1987) has possibly obtained the deepest images of the filamentary structure in M87 using a CCD but of lower resolution than those obtained in this article.

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