New Bright Double Quasar Discovered

GRAVITATIONAL LENS OR PHYSICAL BINARY?

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Spectroscopic observations of bright quasar candidates with the ESO 3.6-m telescope have led to the serendipitous discovery of a close pair of bright quasars with a separation of 3 arcsec. Recent observations of the pair with the ESO New Technology Telescope on La Silla in remote control from Garching on May 11/12 confirm the discovery. The new double QSO may be particularly suited to probe absorbing gas clouds in the early universe.

A Bright Quasar Survey

Bright quasars which can be observed in detail across the whole electromagnetic spectrum are rare objects in the sky. The only way to find such objects is a wide-angle survey of large parts of the sky. Within the ESO Key Programme "A wide angle objective prism survey for bright quasars (P.I. D. Reimers), a group of European astronomers from Hamburg, Liège and ESO (Garching), uses since 1990 the ESO 1.2-m Schmidt telescope on La Silla equipped with an objective prism in front of the main mirror. Each deep 75-min Schmidt exposure thus yields 20,000 to 30,000 low-resolution prism spectra on a 30 × 30 cm Kodak IIIa-J photographic plate. The plates are fully digitized in Hamburg with a fast measuring machine, and quasar candidates are selected by computer using automated quasar search routines. Quasar candidates are then spectroscopically observed on La Silla with the 1.5-m and 3.6-m telescopes in order to obtain redshifts and details that are not visible on the Schmidt plates.

The Hamburg-ESO Bright QSO survey has up to now produced more than 200 bright ($V < 17.5$) quasars in 70 Schmidt fields.

A New Double QSO

Spectroscopic observations of quasar candidates in March 1993 led to the serendipitous discovery of a bright quasar pair. With a separation of 3 arsec the double nature of the object was not recognized on the Schmidt plate. However, the long slit of the spectrograph of EFOSC (ESO Faint Object Spectrograph and Camera) on the 3.6-m telescope "by chance" included the second component. It was only during data reduction at home that it was recognized that the fainter second (B) component has an identical spectrum with component A, strong evidence for image splitting due to a gravitational lense which is typically a massive galaxy in the light path between the quasar and us.

The serendipitously taken spectrum of the fainter B component, however, was too noisy for an unambiguous interpretation.

Observations of the Pair with the ESO NTT – Evidence for Microlensing?

To fully confirm the nature of the object, called HE 1104–1805 AB, we used the ESO NTT telescope equipped with EMMI in the remote control mode via satellite link from Garching in the night May 11/12 to confirm the discovery with better spectroscopic and photometric data.

The facts are now: HE 1104–1805 AB form a pair with a separation of 3.0 arcsec with nearly identical spectra and identical redshifts 2.303. Component A has a visual magnitude V = 16.2, B has 18.0 However, there appear to be small distinct differences between the two spectra. The continuum of component A rises steeper to the blue than that of B, and *all* emission lines (Lyα, C IV, Si IV, C III) are systematically weaker relative to the continuum in A, while, if normalized to, e.g., the C IV profile, the line strengths and in particular their profiles are identical in both components. The systematic differences between the components in both the continuum and the lines are exactly what would be expected if component A is amplified by microlensing due to stars, and the source size is different for the line and continuum forming regions. This hypothesis can be easily tested in the future since the difference between A and

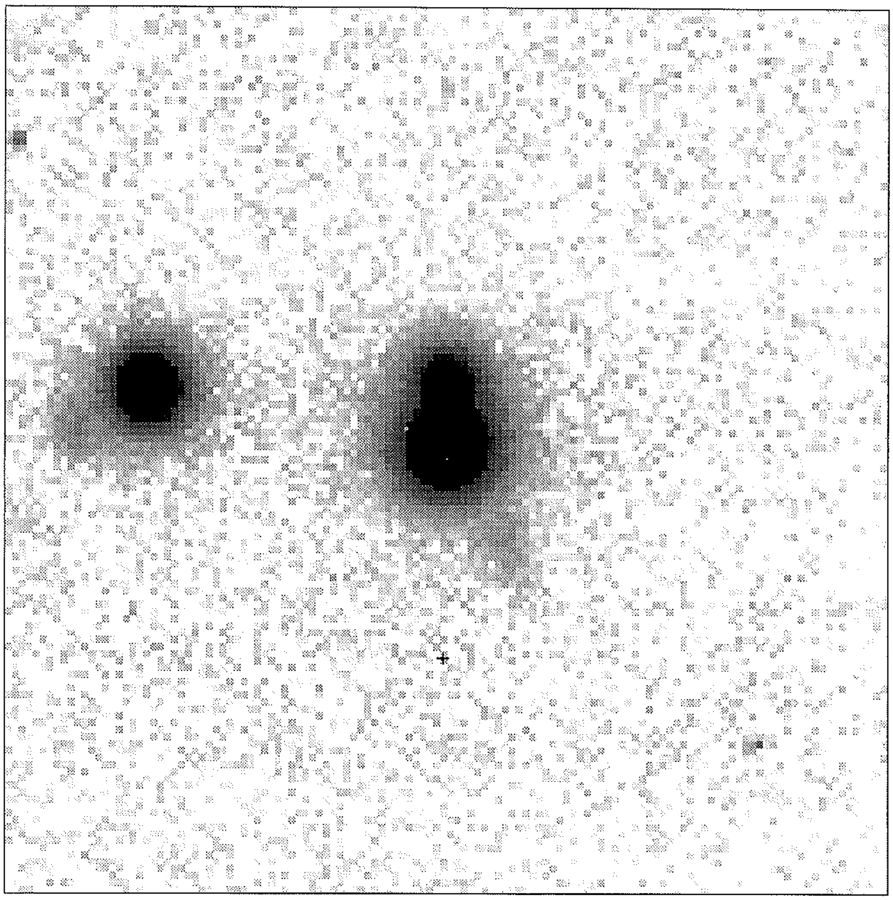

Figure 1: *NTT R image of HE 1104-1805. Composite of three 200-sec exposures. Seeing was 1″8. The faint object south-west (below and right of the bright pair) is a 21^m galaxy.*

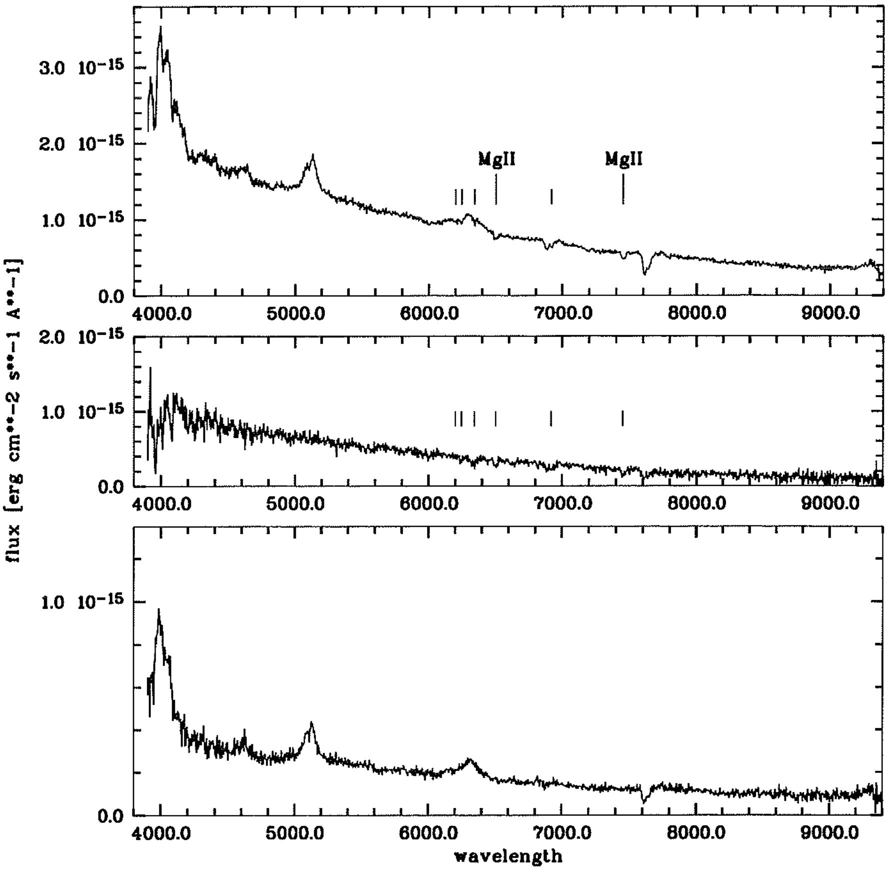

Figure 2: *Spectra of HE 1104-1805 A (upper) and B (lower) taken with NTT and EMMI (red arm, 246 Å/mm grism, 5″ slit width). Exposure time was 600 sec. Resolution is FWHM ≈ 18 Å. The middle "spectrum" is f_{ML} = fλ(A) – 2.8 fλ(B), the hypothetical component in A due to microlensing. Strong absorption features seen only in A are marked.*

B as observed in May 1993 should have disappeared on a time scale of at most years if due to microlensing. If not, HE 1104-1805 A–B is a genuine QSO pair and not two images of the same object.

If it should turn out to be a gravitational lens object, HE 1104-1805 is particularly promising for monitoring of the time delay between the two images which provides a completely independent means to determine the distance scale of the universe or the Hubble constant H_0. This technique had been proposed in 1964 by Sjur Refsdal, 15 years before the first double-image QSO was discovered. The new double, if a lensed object, and if variable, has a predicted "time delay" between the light curves of the two images of several months only, so that the time delay could be measured within one season. However, the first deep images taken with EMMI in the red do not yet show a lens galaxy.

Absorbing Clouds in the Far Universe Along the Line of Sight

There is another distinct difference between the spectra of the two components which has never be seen before in quasar pairs. Component A has a strong absorption line system due to an intervening cloud at redshift z = 1.66 seen in the MgII doublet, five strong FeII UV resonance lines, CIV and, as seen in the UV with IUE, a Lyman edge in the UV at 2450 Å as well as damped Lyα and Lyβ at 3230 Å and 2730 Å respectively. The MgII and FeII absorption is not present in component B, while the CIV doublet is present in B too. Since the observed separation of 3 arcsec projected to z = 1.66 corresponds to a length of about 20 kiloparsecs, this gives the first clear size estimate for a damped Lyα system. The redshift z = 1.66 system might be related to the lens galaxy, since the type of absorption line system seen only in component A is typically produced by disks of galaxies, while the CIV absorption is related to galactic halos.

It will be exciting to observe the new double quasar with the Hubble Space Telescope in the UV and at high spectral resolution in the optical. With HST, absorption lines of the elements C, N and O from the extreme ultraviolet (EUV) are shifted into the satellite UV above 120 nm and enable quantitative abundance studies in absorbing gas clouds around still young galaxies.

Observations with the IUE satellite (International Ultraviolet Explorer), scheduled immediately after discovery on April 29 as a target of opportunity, have confirmed that the object is UV-bright, as had been hoped, and make it an excellent target for the HST.

The new double quasar has also been found to be X-ray loud in the ROSAT All Sky Survey, and it would be important to decide whether the X rays are from the quasar itself or due to an intervening cluster that may be in part responsible for the gravitational lense effect. Target-of-opportunity time to observe the object with the ROSAT PSPC has already been granted.

What Is This?

One of the most important, but perhaps least visible features of the production of a photographic sky atlas is the *quality control.* It ensures that the photographic copies, as far as technically and humanly possible, contain the same information as the original plates. In practical terms, this implies careful sensitometry at the copying and processing machines, and also a thorough visual control of the resulting copy films and plates.

Sky Atlasses have been produced at ESO during the past 20 years and a lot of experience has been gained in the meantime, also what concerns the quality control. The photographers involved know that while it is impossible to achieve a complete transfer of information from the original plate to the copy, for instance of the highest densities, it is very important that the copying process does not "add" artificial "objects" which may be mistaken as real astronomical objects.

It is therefore part of the quality control to check for "plate faults" on the copies which may look like real objects, but which are absent on the originals and are therefore artifacts. Fortunately, modern emulsions are rather clean, and normally few such cases occur.

It was during such a visual control of the Palomar Schmidt infrared plate of northern field 232 for the Palomar/ESO Atlas of the Northern Sky that ESO photographer Gisela Strigl noticed two unusual objects. Both looked like large black spots and seemed strange indeed. However, when she checked with