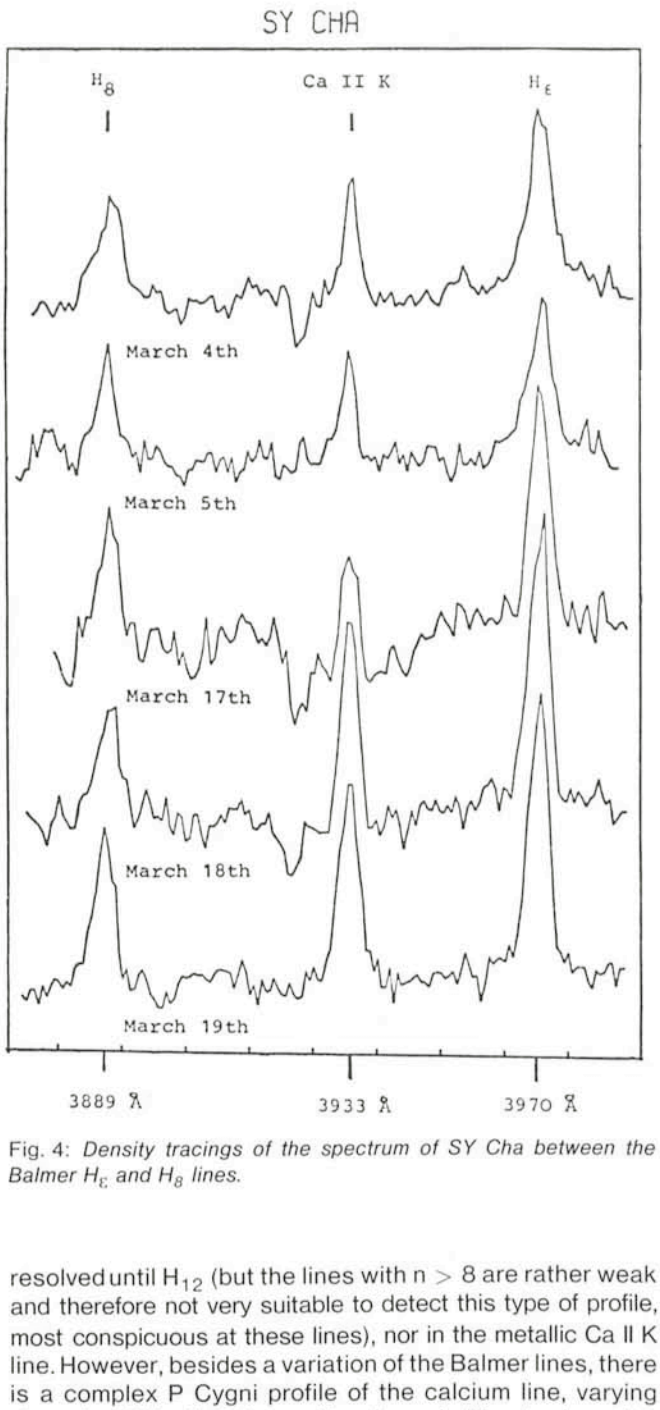

Fig. 4: *Density tracings of the spectrum of SY Cha between the Balmer H_ε and H_8 lines.*

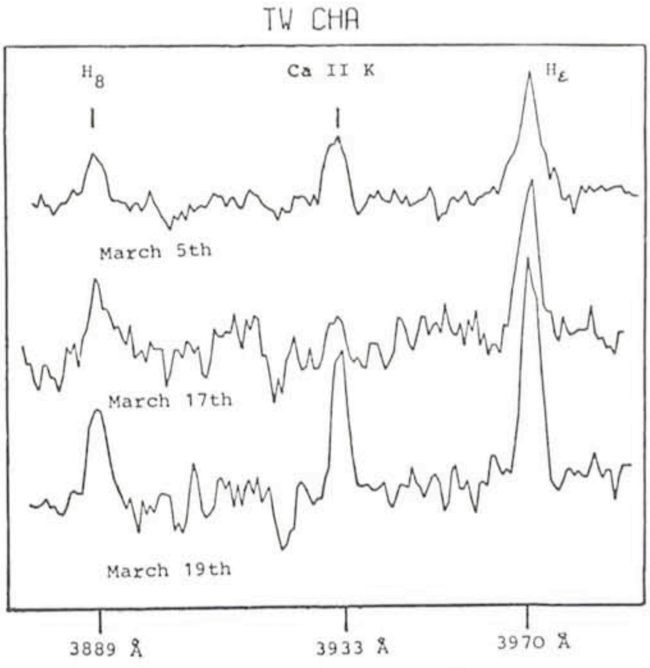

Fig. 5: *Density tracings of the spectrum of TW Cha between the Balmer H_ε and H_8 lines.*

resolved until H_{12} (but the lines with $n > 8$ are rather weak and therefore not very suitable to detect this type of profile, most conspicuous at these lines), nor in the metallic Ca II K line. However, besides a variation of the Balmer lines, there is a complex P Cygni profile of the calcium line, varying strongly within the observational run. In Fig. 4, where the density tracings of SY Cha are plotted, you can see the profile very well in the first spectrum, while vanishing in the second one. Nearly two "photometric" periods later there is again this complex but well seen P Cygni profile in the spectrum of March 17 and it is hardly detected in the last spectrum. A similar behaviour of the Ca II K line of TW Cha can be seen in three selected spectra in Fig. 5.

The lightcurve of TW Cha seems to be well defined, and these three types of spectral features can therefore be attached to the photometric phase of this star. The spectrum of March 5 is correlated to a phase (0.25) of medium luminosity, the spectrum of March 17 is correlated to a phase (0.5–0.6) of high luminosity and the last feature is correlated to a phase (0.9) of low luminosity. This correlation holds true for the other two stars in nearly the same way. Thus we make the conclusion that there is a strong evidence of correlation between the metallic emission line of calcium and its P Cygni profile and the luminosity of the star. But simultaneous photometric and spectroscopic observations based on a time scale of at least two periods are needed to verify this conclusion, to solve the problem of the appearance of different types of P Cygni profiles, and would help to understand the responsible physical processes.

MR 2251–178: A Nearby QSO in a Cluster of Galaxies and Embedded in a Giant H II Envelope

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Very extended nebulosities of high excitation have been discovered around a few active galaxies. For the two radio galaxies 3C120 and PKS 2158-380 they extend over dimensions of at least one arcminute (or about 50 kpc) and can be studied in the optical with a reasonable spatial resolution. These observations give information on the interaction between the active nucleus and its surrounding and on the nature of the gaseous envelope.

In the case of 3C120, the luminosity approaches those of QSOs. In addition, a stellar component has been brought into evidence in the brighter parts of the nebulosity.

The strongest lines emitted by these nebulosities are

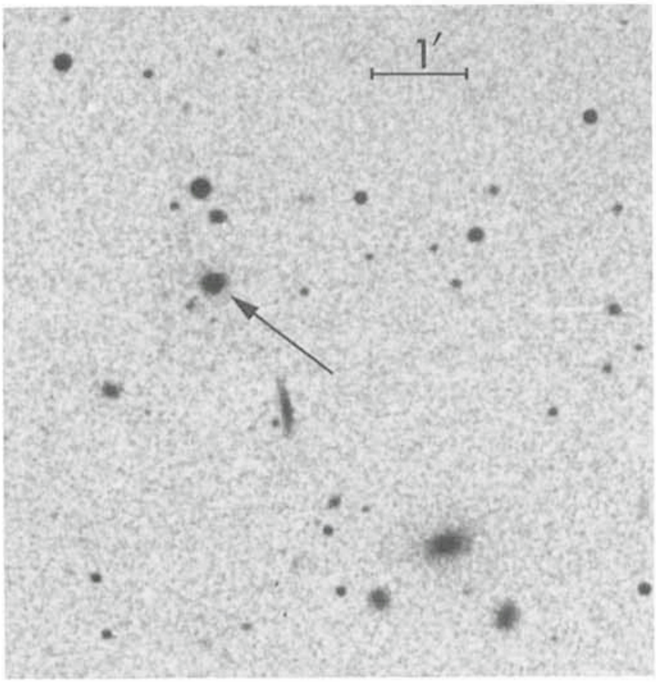

Fig. 1: *The field around the QSO MR 2251–178 from the blue Palomar Sky Survey plate. NE is at the top left corner. The QSO is indicated with an arrow.*

[OIII] λλ 4959, 5007 Å. Spectro-spatial observations of these lines show the motions of the ionized gas. In 3C120 a rotation is discernable, but highly disordered motions are present (Baldwin et al., 1980, *Astrophysical Journal,* **236,** 388). A clear rotation pattern is observed in PKS 2158–30, but the stars do not rotate at all about the rotation axis of the gas (Fosbury, 1980, *The Messenger,* **21,** 11).

The gas observed in 3C120 can simply be the interstellar medium of a normal spiral galaxy and the disordered velocity field could be due to a transfer of momentum from the ionizing radiation escaping the active nucleus. Alternatively the active galaxy may have encountered a gas cloud which is now feeding the nucleus as suggested for PKS 2158–380.

These extended HII nebulosities associated with active nuclei are not a common phenomenon and they are found mainly in radio galaxies. This may reflect some differences in the nuclear activity or differences in the origin and distribution of the gas between Seyfert 1 and radio galaxies.

The hard UV and soft X-ray radiation which escape the nucleus can ionize the gas. This assumption provides a natural explanation for the high excitation of the gas, but is compatible with the observations only if the gas density is low, $n < 1\ cm^{-3}$ (Bergeron, 1976, *Astrophysical Journal,* **210,** 287). The hard radiation spectra in Seyfert 1 and radio galaxies, as derived from EUV and X-ray observations, are very similar and the difference between these two types of galaxies lies probably in the gas distribution.

An observing programme selecting sources with strong UV radiation was started with Alec Boksenberg from University College London, Michel Dennefeld and myself from the Institut d'Astrophysique de Paris and Massimo Tarenghi from ESO. A source of particular interest was the nearby QSO MR 2251–178 discovered from X-ray observations (Ricker et al. 1978, *Nature,* **271,** 35). Its redshift is small, z = 0.064, but the X-ray luminosity is very high, L_X (2 – 11 kev) = 1×10^{45} erg s^{-1}. In the X-ray error circle lies another object, a compact galaxy. The blue Palomar Sky Survey print of the field shown in Fig. 1 reveals the existence of several galaxies a few arcminutes away from the QSO. They constitute an irregular cluster to which the QSO may belong. The QSO is surrounded by a faint nebulosity of 15'' diameter.

Several two-dimensional spectra of the QSO, its surrounding field and a few galaxies of the cluster were taken with the IPCS on the 3.6 m telescope on La Silla. Strong emission lines of high excitation are present in the nebulosity in the close vicinity of the QSO. More striking is the existence of faint [OIII] lines at very large distances (> 100 kpc) from the QSO. Fig. 2 shows these [OIII] lines all the way from the QSO to the south-west galaxy, over a distance of 90'' or 165 kpc (H_0 = 50 km s^{-1} Mpc^{-1}). No nebulosity associated to these lines can be seen in Fig. 1.

This immediately raises the problem of the origin of the gas: is it intracluster gas or is it gas linked to the QSO. The clue to this problem may be given by (1) the overall size of the envelope, (2) its mass, (3) its velocity field.

The HII envelope has an overall size of at least 230 kpc x 60 kpc. Similar dimensions are found for the large HI envelope around the Seyfert 2 galaxy Mark 348 (Morris and Wannier 1980, *Astrophysical Journal,* Letters, **238,** L 7) and for the X-ray emitting gas in groups of galaxies (Schwartz et al 1980, preprint).

From the [OIII] line intensity one can derive an upper limit to the mass of ionized gas. This upper limit is reached if the gas has a homogeneous spatial distribution. The

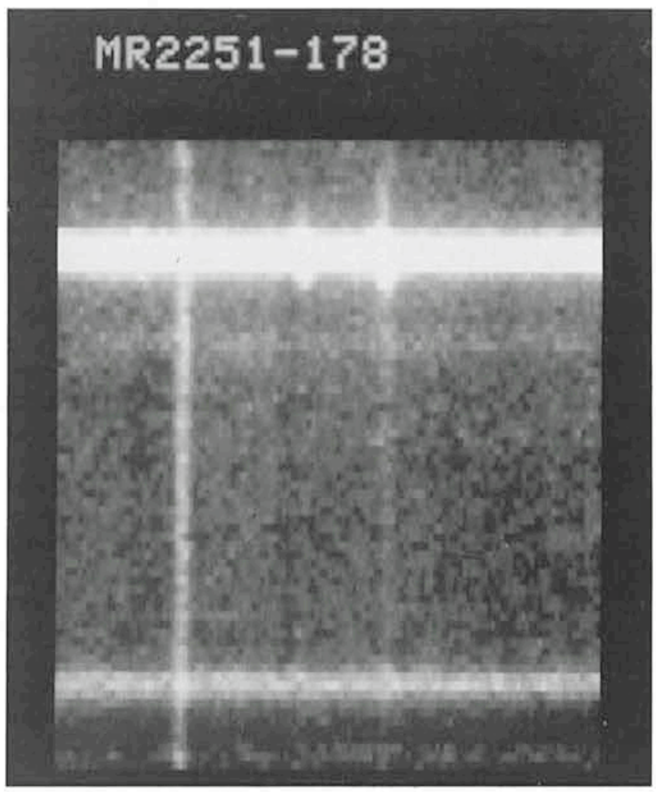

Fig. 2: *A two-dimensional spectrum of the envelope around the QSO MR 2251–178 obtained with the IPCS on the 3.6 m telescope on La Silla. This spectrum shows the redshifted [OIII] lines λλ 4959, 5007 Å and the night sky line NI λ 5198 Å. The QSO is at the top and the galaxy SW of the QSO at the bottom. [OIII] λ 5007 runs all the way from the QSO to the SW galaxy.*

mass of ionized gas within a projected area of 230 x 60 kpc^2 is 3 x 10^{10} ($<n>/n$) $M_\odot$ where $<n>$ is the average gas density of the order of 10^{-2} cm^{-3}. If the gas distribution is not homogeneous, the HII mass can be much smaller than 10^{10} $M_\odot$. The range of masses for giant HI halos is $H_{HI} = 10^{10} - 10^{11}$ $M_\odot$, an extreme case being the spiral galaxy NGC 1961 with $M_{HI} = 1.4 \times 10^{11}$ $M_\odot$ (Rubin, Ford and Roberto 1979, *Astrophys. J.*, **230**, 35). The few known X-ray emitting groups (smaller than the well-known large X-ray clusters) have M (hot gas) = $10^{12} - 10^{13}$ $M_\odot$ (Schwartz et al, 1980, preprint). Although the mapping of the nebulosity around MR 2251–178 is incomplete, it seems that the mass of ionized gas falls in the range of masses of HI envelopes around spiral galaxies and this only if the gas is not clumpy.

The kinematics of the ionized gas are derived from the spectro-spatial observations of the [OIII] lines. A clear rotation pattern is detected within 15 kpc of the QSO. In the SW direction, 50 to 150 kpc away from the QSO, the rotation curve flattens. The total spread in velocity in the observed parts of the envelope is 300 km s^{-1}. This is much smaller than the spread in velocity of the galaxies in the nearby groups. The rotation pattern and the continuity in the velocity field over the whole HII envelope strongly favours an association with the QSO.

Stellar absorption lines are seen close to the QSO. The stellar and gas velocities are similar. However, these absorption lines are detected only at a few positions and we cannot derive the stellar velocity field.

It is worth noticing that the few nebulosities studied spectro-spatially up to now have different characteristics and no general scheme can be given. MR 2251–178 is a weak compact radio source and PKS 2158–380 is a strong extended radio source, yet both are surrounded by an ionized envelope in rotation around the nucleus. The weakness of disordered motions in MR 2251–178 contrasts strongly with the highly disordered velocity field around 3C120.

The envelope around MR 2251–178 appears similar to large HI halos around spiral galaxies. The neutral envelope around the Seyfert 2 Mark 348 and the ionized envelope around MR 2251–178 have comparable sizes and masses (if $n \sim <n>$ in the HII envelope) and both show a clear rotation pattern. The difference in their ionization degree may only reflect their different X-ray power. The QSO MR 2251–178 is a very strong X-ray source with $L_x/L_{opt} \simeq 3$, but the Seyfert 2 Mark 348 is a weak X-ray emitter with $L_x/L_{opt} = 1/100$. The envelope around the QSO can easily be powered by the continuum hard energy source and the degree of ionization observed implies $n \lesssim 10^{-1}$ cm^{-2}.

The Dynamics of Elliptical Galaxies

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Introduction

Two epochs have to be recognized in the study of elliptical galaxies. Prior to 1975 it was believed that a globally correct description of the structural and dynamical properties of these objects had been achieved. It was thought that these galaxies were well understood, not only because their morphology appeared to be simple and they were considered to contain only *one* stellar population, but also, paradoxically, because of the lack of observational data. Then the observation of the first rotation curve called the validity of the currently admitted ideas in question.

These galaxies look more or less like ellipses whose brightness gradients increase towards the centre. They form a sequence ranging from the circular systems (E0) to the more elongated ones (E6) although a scarcely populated class E7 also exists. The parameter is a measure of the ellipticity of the observed image and may not be immediately related to the spatial shape.

A number of empirical laws, like that of de Vaucouleurs, or semi-empirical, like that of King, have been proposed to describe the brightness distribution of elliptical galaxies. De Vaucouleurs' law gives the surface brightness as a linear function of the fourth root of the distance to the centre. It contains two scale factors and has no free parameter. King's law, devised to describe the observed distribution in globular clusters, is based on the assumption of a quasi-isothermal dynamical model. This law, adapted to elliptical galaxies, makes use of two scale factors. One is the core radius of the galaxy which defines the distance along the bissectrice of the axes at which the projected stellar density, and therefore the brightness, become one half of the values at the centre. The other is the tidal radius, beyond which the brightness is zero. The ratio of these two scale factors is a free parameter in the model.

De Vaucouleurs' law is especially convenient to describe the surface brightness distribution of elliptical galaxies. It is easily compared with observations although it does not perfectly represent the light distribution in the central or peripheral regions of some galaxies like, for instance, M87 or NGC 3379.

Before 1972, the only direct access available to the dynamics of ellipticals was through the observation of the velocity dispersion in the centre which gave an estimate of the random motions of the stars. This quantity, derived by using absorption lines, is difficult to obtain even in the centre. Away from it, the spectrum is barely detectable since the brightness of the galaxy decreases rapidly. Other difficulties are due to the fact that these lines are broad and contaminated by the night sky, sometimes even by interstellar absorption lines. Moreover, the absorption spectrum of a galaxy is a blend of different stellar types and results from the integration along the line of sight. These difficulties explain why no observation of this type was done after the pioneering work of Minkowski (1954, in Carnegie Institution of Washington Year Book **53,** p. 26, 1962, in "Problems of Extragalactic Research", IAU Symp. No. 15, p. 112) and before modern detectors became available. In principle the rotation curve could have been obtained more easily using emission lines. However, not