variability although in the near future EXOSAT observations will provide information. More importantly we do not know whether it is an extended source or not. It could be extended up to a diameter of ~2 arcminutes and would not have been resolved by the one IPC observation from the Einstein Observatory. An extended source might point to a cooling flow giving rise to the condensing filaments that we see as low-excitation filaments and conceivably the diffuse Hα and radio halo.

From our spectroscopy of the filaments alone we can provide an estimate of the total Hβ emission = 9×10^{39} ergs/sec. Under the assumption that each hydrogen atom in the cooling flow recombines only once, this estimate converts into an accumulating mass flow of approximately 500 solar masses/year. This is of the same order of magnitude as Fabian and Nulsen (1977) obtained for NGC 1275 (Perseus A). In fact, a number of the other radio and optical properties of PKS 0521-36 remind one of NGC 1275.

At present we cannot assert strongly that the wider environment of PKS 0521-36 supports the idea of an X-ray cooling flow. Certainly it does not belong to a rich group or cluster. There are in the neighbourhood, however, other fainter galaxies whose redshifts are not yet known. And of course we know nothing at all about the possible existence of intergalactic gas clouds in this region.

Summary

There are many phenomenological details associated with PKS 0521-36, some suggestive ideas and not many clear-cut answers. It is clear, however, that new generations of observing facilities can shed further light on many of the problems alluded to here. The Space Telescope will have imaging capabilities that provide spatial resolution of PKS 0521-36 equivalent to that currently possible for M87 with large ground-based telescopes. It will also provide extended wavelength coverage for studying the jet. Future high-resolution X-ray imaging observations will be necessary and possible.

VLA observations to study the spectral and polarization properties of the various resolved components in this source are under way.

All of this may mean that PKS 0521-36 will in the future attract as much attention as the popular, relatively nearby active galaxies.

Acknowledgements

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Observations of High Redshift Mg II and Fe II Absorption Lines in QSO Spectra

P. Boissé, Ecole Normale Supérieure, Paris, and J. Bergeron, Institut d'Astrophysique, Paris

Introduction

When the first absorption system was discovered in the spectrum of 3C191 by Burbidge et al. (1966) it was immediately realized that the analysis of QSO spectra could bring a lot of information on the large-scale content of the universe. The path length to high redshift QSOs is so large that the line of sight towards such objects is likely to intersect galaxies and intergalactic clouds which will leave their signature in the spectrum. Although many questions remain yet unsolved today, some conclusions emerge from the increasing amount of data. It seems now well established that among all systems, those containing sharp metal-rich absorption lines can be associated with intervening galactic haloes. Arguments are mainly of a statistical nature and come from a detailed study of the redshift distribution of the systems. This function appears to be compatible with absorption by randomly distributed clouds and, moreover, the systems tend to cluster in the same manner as galaxies (Young et al. 1982).

In standard Friedmann cosmological models and in the absence of cosmological evolution of the absorbers, the mean number of systems per unit redshift interval, dN/dz, is expected to be of the form

$$\frac{dN}{dz} = \frac{C \times n_0 \times \sigma_0}{H_0} \times \frac{1+Z}{\sqrt{1+2 \times q_0 \times z}}$$

where n_0 is the number density of absorbers and σ_0 their cross section at the present epoch. The knowledge of dN/dz is of great interest since in principle it could yield the value of q_0. In fact, over a large redshift range cosmic evolution effects could

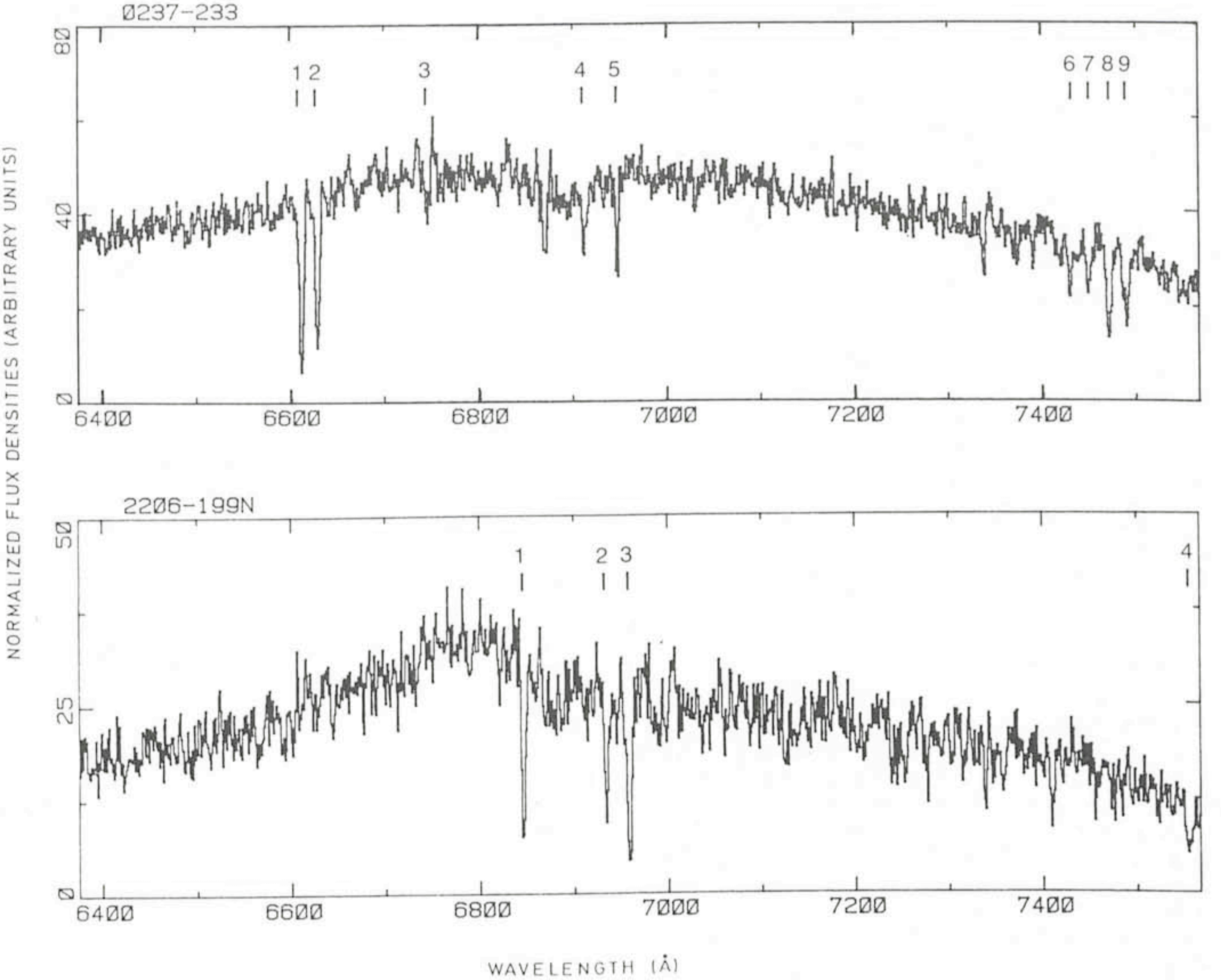

Fig. 1: *Two spectra obtained with the IDS on the 3.6 m telescope at La Silla. In the first one (0237–233) Mg II doublets are observed at z = 1.365, 1.657, 1.672 (lines 1–2, 6–7, 8–9). Other lines are also detected from Mg I at z = 1.365 (3) and Fe II at z = 1.672 (4–5). In the spectrum of 2206–199N a strong Fe II system is found at z = 1.920 (lines 1–2–3–4). In both spectra the absorption near 6870 Å is due to atmospheric oxygen.*

dominate, as found for the Lyα forest systems (very metal-poor population of absorbers).

Moreover, we have to face severe observational constraints which limit the size of the available samples. The identification of absorption lines is sometimes a difficult task and doublets such as those of C IV ($\lambda\lambda$ 1548–1551) and Mg II ($\lambda\lambda$ 2796–2803) which yield unambiguously the absorption redshift must be resolved. As a consequence, the rather large resolution required (e.g. $R \simeq 1500$ for C IV) limits the wavelength interval observed per instrumental setting and a reasonable redshift coverage requires a very large amount of observing time. In practice, as most of the observations have been made in the blue, the value of dN/dz at low ($0.2 < z < 0.8$) and high ($1.2 < z < 3.0$) redshifts is mainly derived from the Mg II and C IV doublets respectively.

What Relationship Between C IV and Mg II Systems?

One puzzling question related to absorption systems is the well-known difference between C IV and Mg II lines, the former being about four times more numerous. This difference could be understood if some cosmological evolution were present with for instance a larger size of the C IV clouds at higher redshift. The present data suggest indeed a positive evolution for the C IV absorbers (Bergeron and Boissé, 1984) although larger samples would be needed to give a more definite answer. Another possibility is the existence of different populations of narrow-line absorption systems. C IV and Mg II lines could sample distinct regions and in this case we would not necessarily expect a strict correspondence between these systems. Using all available data we have built the rest equivalent width (W_r) distribution of C IV and Mg II lines. These two functions look quite different: the C IV distribution is rapidly increasing as W_r decreases whereas no such accumulation is found for Mg II systems at low W_r values (Bergeron and Boissé, 1984). This strongly suggests the existence of two distinct populations or phases. Another way to clarify the relationship between Mg II and C IV lines is to look at systems where both doublets have been observed. There are few such cases and they tend to strengthen the arguments coming from the comparison of the equivalent width distributions.

In order to investigate in more detail the existence of two separate populations of absorbers we have undertaken an observing programme including QSOs with C IV doublets of various strengths already detected in the blue and with Mg II (or Fe II) lines expected in the red (Boissé and Bergeron, 1985). The observations were made with the Image Dissector Scanner (IDS) attached to the Cassegrain Boller and Chivens spectrograph on the 3.6 m telescope with a spectral resolution R = 1700 or FWHM = 4.0 Å. Sixteen QSOs brighter than $m_v = 18.0$ have been observed in the wavelength range 6370–7600 Å. This interval corresponds to a redshift range of 1.18–1.70 for the Mg II doublet and 1.72–2.17 for the Fe II UV 1, 2, 3 lines.

A Low Excitation Line Sample

The spectrum of two QSOs in our sample, 0237–233 and 2206–199N, is presented in Fig. 1. 0237–233 was known to have a very rich absorption spectrum with 4 C IV systems detected at z = 1.365, 1.596, 1.657, 1.672 (Sargent et al., 1980; Young et al., 1982). Three of them show clear Mg II absorption with some additional lines from Mg I and Fe II. For 2206–199 a strong C IV doublet was previously reported by Robertson et al. (1983) at z = 1.920 and we observe an even stronger Fe II counterpart.

The two spectra discussed above are by no means representative of our overall results, as illustrated in Fig. 2, since in most cases Mg II or Fe II lines were not present at an equivalent width limit $W_{obs.,\ lim.} \simeq 0.5$ to 1 Å (depending on the QSO apparent magnitude). More specifically, we observe that: 1) in the 5 systems with rest equivalent width W_r (C IV λ 1548) > 1 Å the low excitation lines are always present and in 4 cases stronger than C IV lines; 2) for the remaining 9 systems with weaker C IV absorption (0.5 < W_r (C IV) < 1.0 Å), there are only two Mg II or Fe II detections with W_r (Mg II λ 2796)/W_r (C IV λ 1548) < 0.5. Thus, there appears to be a relationship between the strength of the absorption lines and the degree of ionization of the system.

Velocity Dispersions Inside Mg II – Fe II Clouds

Another characteristic property of the absorbing clouds is their velocity dispersion possibly different for regions of distinct ionization degree. For our observations, the resolution is unfortunately not large enough to give the true profile of the lines and only a curve of growth analysis can be performed. Then, the velocity distribution law has to be assumed a priori. This may lead to large systematic errors, especially in the estimation of the column densities, if several clouds with different opacities are present on the line of sight.

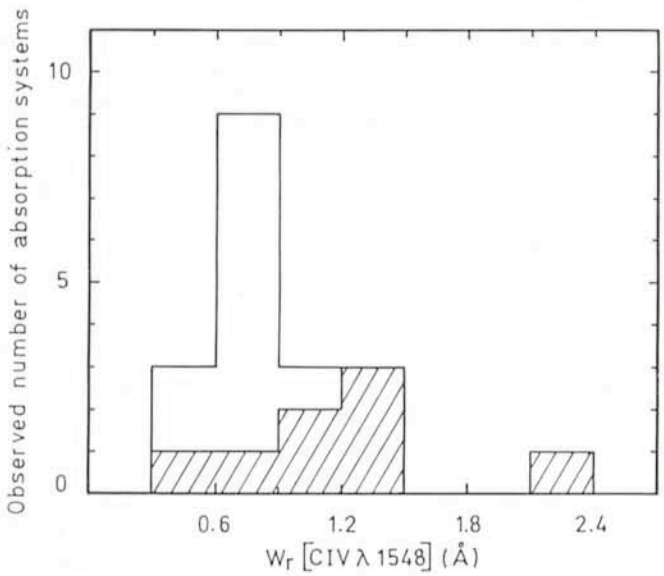

Fig. 2: *The number of C IV systems in the sample as a function of the rest equivalent width of C IV λ 1548 for which Mg II or Fe II lines were expected. The hatched area shows the distribution of the systems for which Mg II or Fe II lines have been detected.*

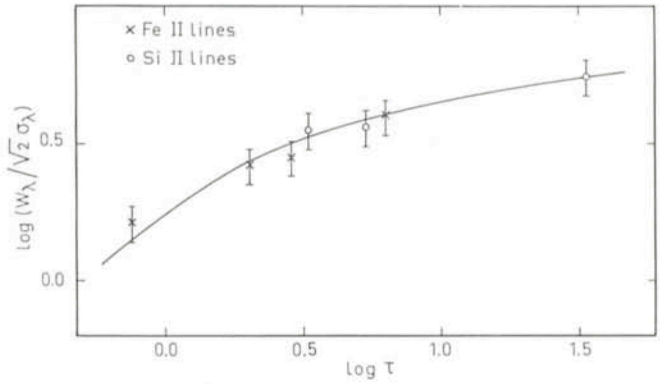

Fig. 3: *Curve of growth for the z = 1.9615 system in 0551–366. A single cloud model with a gaussian velocity distribution has been considered. In addition to the three Fe II lines observed some data on Fe II λ 1608 and on Si II lines have been used. The best fit is obtained with a velocity dispersion of 110 km/s. Each error bar corresponds to a relative uncertainty of 15 % on W.*

For the very strong system at z = 1.9615 in 0551–366 we have added data from Young et al. (1982) to ours and 4 Fe II and 3 Si II lines could be included in the analysis to derive the velocity dispersion of the low-excitation region. The two sets of lines yield consistent results $\sigma_v = 100$ and 120 km/s respectively. When considering the Fe II and Si II lines altogether, as has been done in Fig. 3, the best σ_v value is found to be about $\sigma_v \simeq 110$ km/s. As multiple components could be present, this number represents only an upper limit. The velocity dispersion of the higher excitation region can be derived from the C IV and Si IV doublets and we get a similar estimate as the previous one. For the other low excitation systems we obtain σ_v closer to the standard values of 20–40 km/s.

An Upper Limit on the Number Density of Mg II Systems

In order to determine the true number density of systems per unit redshift interval, one has to be very careful not to include in the sample QSOs with a priori knowledge on the existence of absorption lines, otherwise dN/dz will be overestimated. As our observing programme is biased in that respect, we can only get from our results an upper limit on dN/dz for Mg II–Fe II systems. In the assumption of an empty universe ($q_0 = 0$) and no cosmological evolution the observed number density dN/dz (z) may be extrapolated to z = 0 with

$$\frac{dN}{dz}(z=0) = \frac{dN}{dz}(z)/(1+z)$$

From our number of observed systems (at an average redshift of 1.75) we get

$$\frac{dN}{dz}(z=0) = 0.13 \pm 0.07$$

a value which is to be compared with the one obtained by Tytler et al. (1984) from unbiased observations at lower redshift (< z > = 0.53):

$$\frac{dN}{dz}(z=0) = 0.19 \begin{array}{l} +0.12 \\ -0.08 \end{array}$$

The assumed absence of cosmological evolution thus appears to be compatible with present data even if it is clear that the statistical significance of our results is severely limited by the smallness of the samples.

Conclusion

The comparison between high and low excitation lines in the same absorption systems has strengthened our previous suggestion of the existence of a well-defined class of "low excitation absorbers". In these systems C IV and Mg II (or Fe II) lines are very strong with W_r (C IV λ 1548 or Mg II λ 2796) > 1 Å.

In our Galaxy, high latitude gas has been observed by IUE in front of Magellanic Cloud stars (Savage and de Boer, 1981). It shows an excitation degree very similar to that of the low excitation systems, although the components observed in our Galaxy are generally much weaker. Thus, it seems reasonable to think that these low excitation systems are associated with thick galactic disks. Their physical state (excitation degree, ...) would then be determined mainly by the local starlight radiation field. On the other hand, weaker C IV systems of higher excitation could be related to extended haloes, a phase which would be more sensitive to the external UV radiation field (integrated emission of the QSOs) and therefore more easily subject to cosmological evolution effects.

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Nova Muscae 1983: Coordinated Observations from X-rays to the Infrared Regime

J. Krautter[1], K. Beuermann[2], H. Ögelman[3]

[1] *Landessternwarte Heidelberg-Königstuhl*

[2] *Astronomisches Institut der TU Berlin*

[3] *Max-Planck-Institut für Extraterrestrische Physik, Garching*

During recent years, coordinated observations in different wavelength regions with different instruments have turned out to be a very efficient means of studying variable objects. However, scheduling of such observations is a tricky problem, and one has to plan them well in advance. Difficulties increase, if facilities of several ground-based observatories and astronomical satellites have to be used. But what, if one wants to study a nova outburst? Nova outbursts are absolutely unpredictable and so rare that one does not have any meaningful chance to observe a nova during a normal observing run. There is only one solution for this problem: As soon as a nova outburst is announced, one has to organize an ad-hoc observing campaign. But for that one has to have luck. And that we had.

Let us now explain how we came by lucky circumstances to initiate an ad-hoc observing campaign on Nova Muscae 1983. Two of us (K.B. and J.K.) were on La Silla to carry out simultaneous IR and Walraven photometry of cataclysmic variables. A particular purpose of our programme was to observe dwarf novae in outburst. Since dwarf novae are numerous enough and the quasi period of their outburst short enough, one has statistically a very good chance to observe several of them in outburst during a seven-night run. For this purpose we had a collaboration with F. Bateson, the head of the amateur astronomers of the Royal Astronomical Society of New Zealand (RASNZ). He was to inform us via telex about dwarf nova outbursts detected by his amateurs. In fact, his first telex contained very valuable information; not on a dwarf nova outburst but rather a nova outburst, Nova Muscae 1983. This information from New Zealand reached us via a small detour: Nova Muscae had been discovered more than two days ago (January 18) by W. Liller in the Chilean town Viña del Mar which is about 500 km away from us in La Silla. W. Liller had sent the news of the outburst to the IAU bureau in Cambridge, Mass. From there it was transferred to New Zealand and then to us. The information had to travel 35,000 km, almost once around the earth, to reach us.

We immediately started preparations to observe the nova. At dinner we could persuade spectroscopists to take a spectrum of Nova Muscae. Problems arose due to the brightness of the object which could have damaged the detectors. The

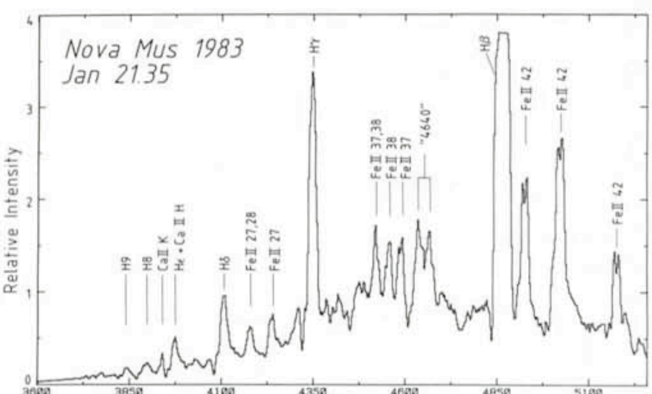

Fig. 1: *Image tube spectrum of Nova Muscae 1983 taken on January 21. The strong emission lines are heavily saturated. From Krautter et al. (1984).*