1 Do large NV/CIV calues indicate N overabundance?

I have considered several alternative possibilities:

a) Contribution of the ILR, as proposed for F10214. by Sergeant et al., Lacy et al.

b) Shocks as dominant emission line mechanism

c) AGN photoionization with a different PL or density of the gas

1.1 The line emission from the Intermediate Line Region (ILR)

F10214. (the gravitational lensed Sy2 type galaxy) emits strong N lines. Sergeant et al. (1997) and Lacy et al. (submitted) propose optically thick Lyα and Balmer lines to explain the UV+optical (rest frame) emission line spectrum.

Interestingly, *they cannot explain the strong N lines and need N to be overabundant.*

Therefore, even if in some objects there is contribution of a high density region (ILR), an overabundance of N is required.

1.2 Shocks as ionizing medium.

As I showed in the plots I sent you in the past, shocks can explain the strength of the NV/CIV and NV/CIII] ratio. My work in HZRG suggests that AGN photoionization dominates the emission line processes. However, I consider this result with care and keep in mind the possibility that shocks can influence the line emission processes. As I said in the past, our objects lie in an area of the diagrams where shock and AGN photoionization models are very close and in principle, we can not distinguish.

There are several reasons, however, why I suspect that shocks are not the explanation for the NV/CIV large values in some objects :

- Maybe the main argument comes from F10214. This objects emits very strong NV and it is a faint radio source. I would expect in this case that jet/cloud interactions (and generated shocks) will be much fainter (if they happen at all) than in any of the other targets in our list. It seems therefore, that shocks do not explain the high NV/CIV values.

- If I am correct, 4C23.56 has been explained in terms of a biconical reflection nebula (knopp et al. 1997), rather than jet-cloud interactions (line widths are very large, though, and the existence of a 'biconical nebulae' is sometimes very dubious). If the biconical nebula is real, AGN illumination dominates the line emission in this object. Again, NV is very strong.

- NV seems very compact in TX0211 (see van Ojik's paper). If jet/cloud interactions dominated its emission, I would expect it to be more extended, at least as extended as Lya (up to 10") which is just a bit stronger than NV in a 5" aperture.

(Do you think that this arguments make sense?)

I will investigate more deeply the possibility that shocks play a role in the high NV/CIV values. I want to see in the literature whether any of the targets presents clear evidence for jet/cloud interactions and see if NV/CIV is low. Do you have any comment on this? Is any of the targets a clear jet/cloud interaction object?

1.3 AGN photoionization: influence of U, density and hardness of PL

Can we explain strong NV/CIV with a different power law or different physical conditions of the gas? Unfortunately, I can not play with mappings since the version I have does not compute NV1240. Contacting Luc is now difficult (he is just moving to Mexico). I am trying to get a new version from Mappings (just in case it computes NV) from somebody else who just asked me for help to learn how to run the program. This will also be useful to study other lines which could be used as diagnostics of metallicity. I have asked Mark Allen to run a few models today, maybe he will help me, I don't know yet.

I can think in the meanwhile of several parameters which could affect the N/C ratios, being AGN photoionization the main ionizing mechanism.

1.3.1 Ionization parameter. Rejected.

van Ojik et al.'s (1994) work and Hamman & Ferland's work (1992) demonstrate that this ratio is not sensitive enough to U and the predictions for NV/CIV do not exceed 0.2.

1.3.2 Hardness of the continuum. Rejected (I think...)

NV and CIV are collisionally excited. We need CIV and NV ions to produce the lines and these ions are generated after the ionization of CIII and NIV ions. The ionization potentials are as follows:

CIII 47.9 eV

CIV 64.5 eV

NIV 77.5 eV

Therefore, those photons able to ionize NIV will also be able to ionize CIV ==> a hard continuum can enhance NV with respect CIV. The question is: how hard must the power law be to produce NV/CIV 0.6 as observed in some objects?

van Ojik studied the effect of changing the hardness of the continuum to explain the large values of NV/CIV in TX0211-22. He compares the values predicted by PL -1.3 and -2 and claims that the ratio did not change appreciably. As a consequence of this, he rejects the possibility that a change in the hardness of the continuum explains the large NV/CIV. From the models I run for my paper on HzRG, I think that a PL harder than -1 will not be able to explain the other line ratios CIII]/HeII, CIV/CIII] and CIV/HeII and I suspect that we will, thus, not be able to enhance NV enough.

Moreover, I think that a change in the hardness of the continuum from object to object is not likely. If this was the case, objects with large NV/CIV would have harder continuum and they should produce larger CIII/HeII values (ratio sensitive to hardness of the continuum and not so much to U). However, there is not such a trend in the data.

Therefore, I would think that changing the hardness of the continuum will not help.

1.3.3 Metallicity

I'll talk about this later

1.3.4 Density. Rejected.

Ferland computes NV/CIV for n(H)=10^{10} cm^{-3} and cannot produce NV/CIV larger than 0.2.

I suspect that CIV/NV is not very sensitive to density. The difference in energy for the two lines is not that large and, moreover, as both of them are recombination lines, this means that they have very, very large critical densities.

In summary: it seems to me that, if AGN photoionization is the main emission line mechanism, we cannot explain the large NV/CIV values, unless metallicity effects are considered (see below).

2 Overabundance of N and starburst activity.

I think that this is a very interesting possibility and has been proposed in the past several times to explain the strong NV line observed in very distant quasars and some radio galaxies. (I'll also have a look to the references you sent me).

* van Ojik proposed this (A&A, 289, 54) to explain the large values of NV/CIV in TXS0211-122. Moreover, to explain this overabundance, he proposes starburst activity.

* The strong [NII]6583 line compared to other optical lines in CygA has also been explained (Tadhunter et al.) in terms of N overabundance. I wonder if the starburst ring might explain that overabundance.

* A few years ago I attended a talk by Ferland at the IAC in Tenerife. He spoke about the N overabundance in the BLR of high z quasars deduced from the NV/CIV ratios. I have looked for the paper (Hamman and Ferland, ApJ, 391, L53). They observed NV/CIV line ratios in QSOs. They estimate N/C abundances from this ratio and study the metallicity of the broad line gas.

Their conclusions are:

1) NV/CIV is larger in high z (z>2) QSOs than the lower z QSOs.

2) z>4 QSOs have N/C ratios ranging from 2-9 times solar.

3) QSOs at high z have metallicities 3 to 14 times solar.

4) To explain the N overabundance, they propose that the high z QSOs are undergoing a rapid chemical evolution and vigorous star formation.

* As I mentioned above, Serjeant et al. propose overabundance of N to explain the N ratios observed in F1020. They also propose starburst activity.

3 The polarization trend

I'll send comments on this another day...