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3 September 1982

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Dear Lorenzo,

I have waited a little while to answer your question about "wiggle wavelengths" in NGC6251 because Rick Perley and I have been working on that very topic in some detail, and I wanted to send you our most complete results.

There are several wavelengths present in the deflections of the NGC6251 jet at different distances from the nuclear core. I enclose graphs showing the deflection of the jet from its mean position angle divided by the angular distance from the core, as a function of angular distance from the core. The graphs show two different distance regimes, namely 0" to 125" and 0" to 500", using data from the VLA 1480 and 1662 MHz observations at a variety of resolutions. The deflections have beem computed by fitting Gaussian functions to the transverse intensity profiles of the jet at a very large number of locations, and determining the positions of the the peaks in the fitted profiles. The data at different VLA resolutions are in excellent agreement where they overlap, showing that the results are neither very sensitive to, nor biased by, the resolution of the radio data.

Even a very casual inspection of these data shows that the oscillation spectrum is complex - there are obvious "beat" phenomena in the data. Both in plots of deflection against distance and (deflection/distance) against distance (as enclosed) it is clear that different wavelengths dominate at different distances from the core. This is all very healthy for interpretation in terms of Kelvin-Helmholtz instabilities, and Rick Perley will report some of our thinking along those lines at the Workshop in Torino. We have made power spectrum analyses of the VLA deflection data at all resolutions and in various distance windows, using both the deflection and (deflection/distance) data. The latter are of interest because an oscillation whose amplitude grows linearly with distance from the core appears in that data as a simple sine wave.

We have concluded that there is significant power in both sorts of deflection data at projected wavelengths of 143", 31", 17.5", 12" and 9". For H=75 km/s/Mpc, the image scale is 429 pc per arcsec. The long-wavelength wiggle reported previously by the Cambridge group corresponds to the 143" wavelength in this spectrum. The discrepancy over the value of the wavelength is probably due to the fact that they made a visual estimate of the wavelength from a rather noisy plot of their data. If you compare their data directly with ours, you will see that there is sensible agreement. Our data have very much better resolution and signal to noise than theirs however.

In terms of wiggle wavelength to jet radius, the situation in now very complicated. The jet expands in a very complicated manner and the radius changes by a factor of 40 over the range that we can measure. Furthermore, the widths of the jet as estimated from its brighter isophotes do not everywhere show the same structure as the widths estimated from the lower ones. There are changes in the symmetry properties of the profiles in the outer jet which suggest that some of the small-scale structure is clumping and deflecting on scales which are not shared by the more diffuse emission. Broadly speaking though the 143" oscillation dominates a region of the jet where the radius is of order 8". The 31" oscillation dominates where the radius is of order 5.5", and the 9" oscillation where the radius is of order 1.9". The wavelength-to-radius ratios for these are thus ROUGHLY 17.5, 5.6, and 4.75 respectively.

The available constraints on depolarization of the jet make it very difficult to interpret the 9" and 31" oscillations as the dominant helical mode. The 143" oscillation can quite plausibly be the n=1 helical mode however, and we are making that interpretation while preparing our paper on NGC6251. It is then curious that the dominant pinching mode with the same physical parameters for the jet would have a wavelength-to-radius ratio of 5.4 (we estimate the Mach number from the initial expansion rate as being about M=9). This is close to the observed values for both the 9" and 31" oscillations where they dominate, and leads to some speculation regarding coupling between the helical and pinching modes.

We should have much to discuss about this and I am glad that I am able to send Rick Perley to your Workshop even though the pressure of teaching here at Queen's means that I cannot come myself. Again my apologies for taking a while to reply to your letter, but you can probably see that the situation has become rather more involved than we thought a year ago, but very probably it also contains much more of the physics that we are all looking for.

I will indeed send preprints of the work as soon as we have them available. The paper on NGC6251 has grown like a balloon and filled my entire summer; the work on NGC315 and 3C219 is therefore waiting for a while until NGC6251 is complete and until the disruptions of the new teaching year have gone by.

Be assured that you are high on our list for receiving the new work when we have it in a legible form ! I am looking forward to meeting you again so that we can resume some of the enjoyable discussions we had while you were in New Mexico. I shall be here at Queen's until the end of December at least. After that I may be going to Charlottesville.

With best personal regards,

Yours sincerely,

Alan

Alan H. Bridle
Professor of Physics