for the external domains of receptors it might help explain their unexpectedly large sizes. It will obviously be important to determine the location and extent of the ligand-binding sites in each case.

Ullrich *et al.* show that there is probably a single gene for the insulin receptor in the human genome[1]. As expected, it is expressed in placenta and in cell lines that have insulin receptors. A number of different mRNAs seem to be expressed from the gene; since the insulin-like growth factor 1 (IGF-1) receptor is very similar in structure and enzymatic function to the insulin receptor, it is possible that some of the mRNAs come from the IGF-1 receptor. Given the homology between the two receptors we can anticipate that this matter will be resolved shortly by the cloning and sequencing of the IGF-1 receptor.

Last time I wrote in these columns, I expressed the hope that a comparison of the structures of the different receptor protein-tyrosine kinases would give us clues to the mechanism of transmembrane signalling[4]. Although there are several obvious analogies between the structures of the insulin and EGF receptors, unfortunately no startling mechanistic insight emerges. Both receptors cross the membrane once and have protein-tyrosine kinase domains in similar locations. The differences between the sequences linking these domains to the transmembrane domains in the two receptors suggests that no defined sequence in this region is required for signalling. It is interesting that the insulin-binding subunit is linked to the enzymatic subunit through disulphide bonds, while in the EGF receptor they are part of the same polypeptide chain. Subunit-subunit interaction, however, is a common feature of many allosterically-regulated proteins. The dimeric nature of the insulin receptor may be significant; Ullrich *et al.*[1] suggest that the insulin-binding site could be formed by the two α-chains, yet there is evidence that the disulphide bonds between the two α-chains are not required for insulin binding nor for the biological response[9]. Certainly it is easier to imagine how ligand binding could transmit a signal through a dimer structure, with its inherent rigidity, than through a monomer.

Clearly ideas on mechanisms of signal transmission can now be tested by direct molecular manipulation of the insulin receptor and interchange of its domains with those of the EGF receptor. Perhaps we will also learn why EGF and insulin trigger such different responses. □

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Astronomy

A Seyfert galaxy joins the jet set

from Beverley J. Wills

THE Seyfert galaxy NGC 4151, a nearby active galaxy, is back in the pages of *Nature* again. But the revelation by Ulrich *et al.* on page 747 is the most exciting so far. Thanks to the intrepid International Ultraviolet Explorer satellite, we now have the first optical evidence for high speed jets of material squirted from the nucleus of an active galaxy.

A popular model of the nucleus of a quasar, suggested by many observations and in line with current theoretical ideas, consists of a spinning black hole whose gravitational field provides the basic energy for the enormous flux of electromagnetic and relativistic particles observed by analysis of the optical and ultraviolet spectrum. A large fraction of the flux forms beams, moving at bulk relativistic speeds outward along the axis of rotation and probably coupled to, and fed by, a high-temperature ($2\text{-}4\times10^4$ K) accretion disk around the black hole. Direct evidence for these 'jets', extending for parsecs or megaparsecs, comes from radioastronomical observations, especially Very Long Baseline Interferometry, which reveals 'superluminal' expansion of knots away from an active core, aligned with long, narrow and often very straight jets connecting the core with outer, extended (kiloparsecs) fossils of jet activity. The frequently observed one-sidedness of the narrow jets is attributed to relativistic Doppler enhancement of the flux from the approaching beam, although this interpretation is less satisfactory at very large distances from the nucleus. Two-sided jets are more common in lower luminosity objects, perhaps indicating lower bulk velocities.

The central 'engine' is surrounded by dense (about 10^9 atoms cm^{-3}), fast-moving cloudlets or filaments which are photoionized by the strong ultraviolet continuum from the engine and give rise to strong broad emission lines, which are typically 2,000 - 20,000 km s^{-1} wide. Photoionization calculations suggest that these cloudlets extend about 0.1 - 100 parsecs from the central ionizing source, depending on its luminosity.

For the lower luminosity quasars, like that embedded in NGC 4151, this prediction has recently been confirmed by observations of changing broad emission line fluxes as the cloudlets respond to time variations in the central ionizing flux, after travelling at the speed of light across the broad-line region (BLR). The BLR lies within a much larger (up to kiloparsec size), low-density region, approximately 10^4 - 10^7 atoms cm^{-3}, which is also photoionized, and gives rise to relatively narrow emission lines, a few hundred km s^{-1} wide. In nearby active galaxies, such as NGC 4151, the outer parts of this narrow-line region (NLR) are spatially resolved. Because of the long time it takes for light to travel across the NLR, these emission lines should not respond to changes in ionizing continuum over time spans that we can study, as is borne out by observation. NGC 4151, although its radio luminosity is too low for it be classified as a radio galaxy or radio quasar, has evidence of small-scale (200 parsecs) radio jets (Booler, R.V. *et al. Mon. Not. R. astr. soc.* **199**, 229; 1982) that seem to be related to, and interacting with, outflowing NLR material (Heckman, T.M. & Balick, B. *Astrophys. J.* **268**, 102; 1983).

Ulrich *el al.* now report two newly-detected narrow (less than 1,500 - 3,000 km s^{-1}) emission lines, straddling the broad C IV λ1549 line in the spectrum of the nucleus of NGC 4151. These show up four-fold variations in strength over a few days and are apparently not indentifiable in the rest frame of the galaxy. The authors suggest that these lines may be Doppler-shifted C IV λ1549 arising from shock-excited material in a two-sided jet. If this is true, then we have the first direct measurement of the velocity of material in the line of sight associated with an extragalactic jet; the actual velocity is suggested to be about 0.1 c. This discovery opens up the exciting possibility of studying the mysterious region near the base of the jets, using optical emission-line observations of the jet or jet-entrained material.

Ulrich *et al.* argue that if these lines are indeed C IV, they are most unlikely to be from two photoionized, independent ('free-flying') clouds, either falling in, falling out or orbiting. The observed velocities have varied very little over three years, and the strengths of the two lines change almost simultaneously (within 10 days). The latter limit is based essentially on only one fairly well-observed, rapid increase among several smaller fluctuations, and it is obviously desirable to confirm this and improve the limit on the variation of the relative wavelengths.

Unfortunately, it is going to be difficult to investigate this phenomenon in other galaxies. NGC 4151 is a special case because it is nearby and active, and so is bright and therefore easy to observe, despite its relatively low intrinsic luminosity. Recently, both its variable nuclear continuum and, because of its small BLR, the broad C IV wings have been faint, and it is these conditions which have enabled the narrow line component to be discovered. □

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