Astronomy

What triggers a quasar?

from C. Martin Gaskell

RECENT observational evidence has greatly strengthened the long-standing view that almost all galaxies have the potential to be quasars (and indeed quite possibly were quasars sometime in the history of the Universe), but that some kind of trigger is needed. The question is, what is the trigger for a galaxy to turn into a quasar or some milder quasar-like object such as a radio galaxy or a Seyfert? A new study by Kennicutt and Keel[1] supports the old idea that interactions between companion galaxies are a very important way of stimulating quasar-like activity at all levels[2,3].

The standard model of the tremendous energy release in quasar activity involves accretion of matter onto a massive black hole[4], with 10^6–10^9 the mass of the Sun[5]. Such black holes probably form as the result of stellar collisions in the densely packed galactic nucleus. It has been known for a long time that quasar activity was much more common in the past than it is now[6,7]. Since massive black holes do not vanish overnight there must be many dormant black holes sitting in galactic nuclei that are not currently showing quasar activity. Our own Galaxy could well have such a dormant black hole since recent spectroscopic surveys of complete samples of galaxies[8,9] show a low level of nuclear activity in perhaps a half of all spiral galaxies. Therefore, although the existence of a giant black hole is believed to be a necessary condition for quasar activity, it is obviously not a sufficient one. Something else has to happen — the 'monster' has to be fed.

How do you feed a giant black hole? The possibilities considered are too numerous to list, but recent observational studies are reviving the idea that collisions and close interaction between galaxies are responsible. This idea, originally proposed in 1954 by Baade and Minkowski[10] for one of the first radio galaxies identified (Cygnus A), subsequently fell into disfavour[11]. However, recent high-resolution faint-imaging surveys of relatively nearby quasars show that over 30 per cent of quasars are currently interacting with a nearby galaxy[3,12]. Seyfert galaxies , too, have close companions[13]; and surveys of samples of nearby galaxies independently suggest that galaxies in close groups and pairs possess both stronger-than-average central radio sources[14] and stronger-than-average nuclear emission-line activity[8].

Now, Kennicutt and Keel[1] have made complete spectroscopic surveys of three samples of galaxies: a control sample of non-interacting galaxies; a sample of close pairs; and a sample of closer pairs, showing visible signs of strong tidal interactions. The results are very striking. As expected, about 4 per cent of the control sample show strong Seyfert (quasar-like) activity; but, interestingly, as many as 11 per cent of the close pairs show such activity and a staggering one-third of the tidally-interacting pairs are Seyferts. Not only are there more cases of the most violent nuclear activity in the closer pairs but almost all galaxies in close pairs seem to show enhanced activity, as shown by their emission-line properties. In short, this survey has shown not only that active galaxies are frequently interacting, but also that interacting galaxies are frequently active.

It is now very clear that what happens in the inner few light years of a galactic nucleus is not independent of what happens in the outer edges of the galaxy, a hundred thousand light years away. It seems that tidal disruption of a galactic disc in a close encounter can drive gas into the nuclear regions and either fuel quasar activity or at least cause a burst of star formation[2,15]. Both theoretical and multi-wavelength observational studies of the details of this fuelling process will be a rich field of research for the next few years.

Meanwhile, lest any aspiring reader be tempted to suggest that a close encounter of our Galaxy with another triggered quasar activity and brought about the extinction of the dinosaurs, let me say that quasar activity has already been shown to be totally harmless to life on Earth[16,17]. □

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In the article 'Early evolution of leaves' by J. B. Richardson (*Nature* **309**, 749; 1984), there was a mistake in the ninth sentence of the third paragraph. It should read '. . . and work by Andrews, Gensel, Kasper, Banks and Hueber indicates a high diversity of plants at that time (see *inter alia* ref. 9)'.

100 years ago

ON THE EVOLUTION OF FORMS OF ORNAMENT

THE leaf in Dracunculus has a very peculiar shape: it consists of a number of lobes which are disposed upon a stalk which is more or less forked (tends more or less to dichotomise). If you call to your minds some of the Pompeian wall decorations you will perceive that similar forms occur there in all possible variations. Stems are regularly seen in decorations that run perpendicularly, surrounded by leaves of this description. Before this, these suggested the ideal of a misunderstood (or very conventional) perspective representation of a circular flower. Now the form also occurs in this fashion, and thus negatives the idea of a perspective representation of a closed flower. It is out of this form in combination with the flower-form that the series of patterns was developed which we have become acquainted with in Roman art, especially in the ornament of Titus's Thermae and in the Renaissance period in Raphael's work.

It is difficult to obtain a firm basis on which to conduct our investigations from the historical or geographical point of view into this form of art, which was introduced into the West by Arabico-Moorish culture, and which has since been further developed here. There is only one method open to us in the determination of the form, which is to pass gradually from the richly developed and strongly differentiated forms to the smaller and simpler ones, even if these latter should have appeared contemporaneously or even later than the former. Here we have again to refer to the fact that has already been mentioned, to wit, that Oriental art remained stationary throughout long periods of time. In point of fact, the simpler forms are invariably characterised by a nearer and nearer approach to the more ancient patterns and also to the natural flower-forms of the Araceae.

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