earlier findings on a second-messenger role of this substance[4,5].

We now have a situation in which Ca^{2+} entry and Mn^{2+} influx following depletion of intracellular Ca^{2+} stores could be mediated by two different mechanisms, possibly acting in parallel in the same cell. The increase in cytoplasmic Ca^{2+} triggered by Ins(1,4,5)P_3 could activate the channels described by Lückhoff and Clapham (causing Ca^{2+} and Mn^{2+} influx). This would provide positive feedback for calcium entry and could be important for oscillatory changes in the concentration of intracellular Ca^{2+}. It may be that Ins(1,3,4,5)P_4 serves as a co-factor that determines the duration of the response; on the other hand, depletion of intracellular Ca^{2+} stores by Ins(1,4,5)P_3 could trigger Ca^{2+} influx through the current described by Hoth and Penner. This Ca^{2+} entry is subject to negative feedback regulation by cytoplasmic calcium, and could be important for calcium homeostasis at some elevated level. It will be interesting to learn how the filling state of the stores might transmit a signal to the plasma membrane [4,9,10].

All of these mechanisms could in principle act in parallel. Indeed Mn^{2+}-permeable and Mn^{2+}-impermeable calcium-entry pathways seem to coexist in liver cells[11]. The variety of cellular responses to external agonists may reflect which mechanism is expressed in a given cell, and to what degree. □

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COMPTON OBSERVATORY

Gamma-ray power from 3C279

Giovanni F. Bignami

A NEW holder for the title of brightest γ-ray source in the Universe has been found by NASA's Gamma-Ray Observatory, now called the Compton Observatory[1]. The source, the distant quasar 3C279, is a well known active object characterized by rapid variations in luminosity at other wavelengths.

The satellite-based Compton Observatory, named in honour of the physicist A. H. Compton who discovered the laws of electron–photon scattering, has been in operation for several months now, and is half-way through the first full γ-ray survey of the sky. Its first great success was to show that γ-ray bursters are distributed isotropically over the sky, and hence could originate outside our Galaxy (see refs 2, 3). The new discovery was made using the satellite's Energetic Gamma Ray Experiment Telescope (EGRET), a spark chamber that detects γ-rays with an energy in excess of tens of megaelectronvolts (MeV) by tracking electron–positron pairs made in γ-ray interactions. Similar in design to the earlier SAS-2 and COS-B γ-ray satellites, EGRET has vastly improved sensitivity and angular and energy resolution.

Nevertheless, the telescope was hardly pushed to get its first big result, described by Hartmann *et al.* in the latest issue of the *Astrophysical Journal Letters*[1], the chance discovery of a strong γ-ray source in the constellation of Virgo. EGRET easily pinpointed the source to within a few arcminutes, quite adequate for it to be identified with 3C279. This quasar is of the 'optically violent variable' type and is also a strong and variable X-ray source at a redshift of about 0.5, or over 5,000 megaparsecs away (for H_0 = 75 km s^{-1} Mpc^{-1}), and the first object for which so-called superluminal velocities were seen.

As such, it is much further away than the only other quasar ever seen to radiate γ-rays, 3C273, which is coincidentally in the same part of the sky. 3C273 was seen by COS-B in the late 1970s, as 3C279 would have been had its flux been as high as reported by Hartmann *et al.* — a sure indication of the quasar's variability. EGRET also measured the spectrum of 3C279: from 50 MeV to 3 GeV, it is uniformly very 'hard', well fitted by a power law with a photon index of about −2. This indicates that the energy emitted at each frequency remains constant with increasing frequency, a tough achievement for any γ-ray source and quite unlike the spectrum of 3C273.

Curiously, a second imaging instrument aboard the Compton Observatory, COMPTEL, which is sensitive to lower-energy (MeV) γ-rays, has completely failed (at least so far) to see 3C279 (V. Schönfelder, personal communication). This may imply a significant change in the spectrum below about 10 MeV. Nevertheless, the output of 3C279 is a staggering 10^{48} erg s^{-1} (or more), just in γ-rays — on a par with the total luminosity of the title holder last year for the 'brightest' object in the Universe, the infrared galaxy 10214+4724 at a redshift of 2.5 (ref. 4). The γ-ray luminosity of 3C279 is, in any case, ten times bigger than all the rest of the quasar luminosity.

Theorists are getting busy. The problem is a classic one in studies of active galactic nuclei: how can so much energy be produced at and radiated from the active galaxy's central 'engine' (usually thought to be a massive black hole)? One must also account for the shape of the spectrum. In the case of 3C279, this problem is more formidable than usual because of its huge luminosity and hard spectrum. If the radiation is beamed along a single direction, not distributed isotropically, the problem is eased, because the total luminosity is decreased, but not drastically.

Photon–photon absorption limits the amount of energy that can escape from a bright source if the density of photons at different energies is high enough. Theorists have already had to cope with this limit in explaining the γ-rays from the weaker 3C273 source. The difficulty all depends on the size of the source region, which can be inferred from the timescale for the variability (a source can change only with a maximum rate determined by the light transit time over its dimensions). In the case of 3C279, for which rapid variability is already known at optical and X-ray wavelengths, this scale problem could be even worse than first realized, as unconfirmed reports indicate that EGRET detected significant variations over its two-week observation period. Taken at face value, this implies that those 10^{48} erg s^{-1} come from a region at most a few light days across, so that it is hard to see how high-energy photons could find their way out.

The synchrotron self-Compton process is the one normally considered for the luminosity of active galactic nuclei. In this, the energy of photons is boosted in collisions with high-energy electrons according to the Compton effect (as is only appropriate for the Observatory). This process could occur in a high-energy jet streaming out of the active nucleus and so would account naturally for any beaming of the radiation and, by virtue of its instability, for the observed variability. But if there are charged particles in the jet, and if they are responsible for the γ-rays seen by EGRET, they must have unusually high energies. Their spectrum would have to be as hard as that of the cosmic-ray protons seen at the Earth. And those have been an intractable puzzle for astrophysicists for several decades. Gamma-ray quasars may be few and far between (or may have been, now that the EGRET is finally flying), but they may well represent a big step forward for both physics and astronomy. □

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1. Hartmann, R. C. *et al. Astrophys. J.* **385**, L1–L4 (1992).
2. Lindley, D. *Nature* **354**, 20–21 (1991).
3. Meagan, C. A. *et al. Nature* **355**, 143–145 (1991).
4. Rowan-Robinson, M. *et al. Nature* **351**, 719 (1991).