was repeated ~10^5 times to achieve a suitable signal-to-noise ratio.

Smooth sinusoidal population oscillations were observed when $H_1 << H_0$, as observed previously with NV centers (*4*) and quantum dots (*5*). However, when Fuchs *et al*. increased H_1, the sinusoidal curve displayed increasingly anharmonic components. Finally, at H_1 values nearly as large as H_0 the response became altogether nonlinear. In fact, at some time points, the spin state flipped much faster (<0.5 ns) than would be possible in the valid RWA regime, whereas at other time points, the spin rotation appeared to stall. These outcomes are a direct result of the competition between H_1 and H_0.

This approach could be used as a tool for probing fundamental physics, for example, in quantum control theory (*6*). With further optimization, this experiment provides a way forward for ultrafast control of a qubit for quantum information processing. A crucial metric in this endeavor is the number of times a qubit can be manipulated before its information dissipates. Ultrafast qubit manipulation is more straightforward for transitions with a large energy splitting (and hence large H_0) using laser pulses in the valid RWA regime—as shown for optically manipulated spins in quantum dots (*7*). However, the extraordinary spin coherence in diamond justifies the effort by Fuchs *et al*., who demonstrated that more than 1 million qubit operations are possible at room temperature before decoherence occurs.

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ASTRONOMY

Two Missions, One Microquasar

The detection of high-energy gamma rays is providing a better picture of the structure and dynamics of microquasars.

Giovanni F. Bignami

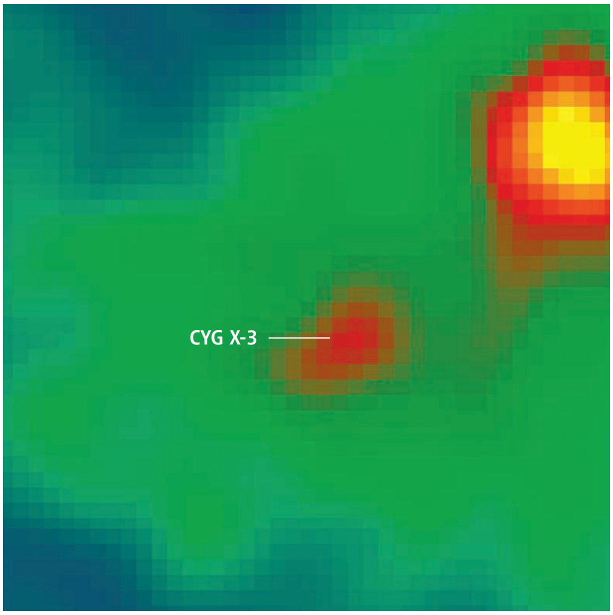
It has been on the suspect list for more than 30 years, but now we know for sure, smoking gun and all, that x-ray source number 3 in the constellation of Cygnus (Cyg X-3) emits gamma rays. After many near (and wide-of-the-mark) misses, we now have incontrovertible evidence coming from two independent gamma-ray telescopes, AGILE (*1*) and Fermi (*2*), the latter reported on page 1512 of this issue.

The data were accumulated over the past 2 years, during which the object—an x-ray binary with a short (4.8 hour) orbital period, no pulsations, and strong, erratic radio emission—underwent several of its x-ray and radio ups and downs. It now appears that its 100 MeV gamma-ray emission is somehow linked to these modulations. It may turn out that gamma rays and the particles producing them hold the key to this peculiar x-ray binary, which, in modern parlance, is referred to as a "microquasar." Like quasars, Cyg X-3 could contain a small accreting black hole, and it has relativistic jets.

A strange source then, Cyg X-3. Given the spartan facilities aboard an Aerobee rocket, back in the presatellite stone age of x-ray astronomy, the initial report of its discovery in 1966 (*3*) is to be read with reverence. Because Cygnus is located in a difficult-to-probe region of the Galaxy, it took all of 30 years for understanding the nature of the noncollapsed object in the system (*4*).

Meanwhile, observations (correct and incorrect) accumulated at all wavelengths, from radio to PeV gamma rays, and even (unconfirmed) cosmic rays. In the early 1970s, NASA's small astronomy satellite-2 (SAS-2) staged a claim for a positive Cyg X-3 detection. That claim, however, was not confirmed either by the European Space Agency's (ESA) Cosmic ray satellite (Cos-B) or by NASA's Compton Gamma-Ray Observatory (CGRO). For decades, conventional wisdom followed a simple model of the source as a young neutron star in a binary system (*5*), where the gamma rays were a result of particles accelerated at a shock discontinuity.

Because none of the observational high-energy claims stood the test of time, work concentrated on the radio-to-x-ray phenomenology of Cyg X-3. The object itself must take the blame for part of the difficulties for the high-energy detections of Cyg X-3. This binary, or microquasar, spends most of its time in states characterized by strong "hard" x-ray emission (tens of keV) and by intermediate values of radio emission. Photons are somehow "killed" above 1 MeV, and no gamma rays can thus be detected. It is only at special moments, when radio emission is quenched and hard x-rays disappear into soft ones, when Cyg X-3 can unleash itself and seriously accelerate particles. It is the interaction of such particles (electrons or protons) that produce gamma rays. In short, observing a microquasar for a year is like observing a quasar for a million years.



Coming into view. The detection of gamma rays by the space-based satellites Fermi LAT (*2*) and AGILE (*1*) is providing a clearer picture of the microquasar Cygnus X-3.

Istituto Universitario di Studi Superiori (IUSS), Lungoticino Sforza 56, 27100 Pavia, and Accademia dei Lincei, Palazzo Corsini, via della Lungara 10, 00165 Roma, Italy. E-mail: giovanni.bignami@gmail.com

All of the above, however, remained a somewhat fuzzy and unsatisfactory model until a new generation of gamma-ray missions came along to prove it, starting a few years ago. Back in 2003, at the low-energy end, ESA's Integral satellite reported a solid observation up to 100 keV (*6*). But the breakthrough came with the 100-MeV range, which took on new vigour with the launch of ASI's (the Italian Space Agency) AGILE in 2007 and of NASA's Fermi in 2008.

The Cyg X-3 paper by AGILE (*1*) refers to observations of the source over about 2 years (2007 to 2009). On four occasions during that period, AGILE saw gamma rays coming from the source at precisely those transitional states referred to above, that is, when the radio and hard-ray emissions appear to be suppressed. Of equal interest is that, on those special occasions, the gamma-ray–emitting state was followed by those strong radio jets for which CygX-3 is famous. It stands to reason that relativistic (radio) jets can only be formed when relativistic particles are being accelerated, and thus when gamma rays are being produced. A palpable hit, at last, for gamma-ray astronomy

A similar long-term correlation between radio and gamma ray emission has been found by the Fermi Large Area Telescope (LAT) (*2*), an instrument that allows for a much richer photon harvest than AGILE. The LAT detects Cyg X-3 at the right position with a significance of 29 standard deviations. Moreover, it detects the source 4.8-hour orbital periodicity, and does so during "active" source times when the accelerator is "on" and gamma rays are being copiously produced. They also find excellent correlation between the radio and gamma-ray emissions.

As for the source physics, there are a couple of clues. One is the gamma-ray spectrum of Cyg X-3, which appears to be steep. Electrons would be favored as the parents of such a variable, steep spectrum, especially if they were located away from the accretion disc and thus see the stellar radiation field as anisotropic. The second clue, reported by AGILE and confirmed by LAT, is that the active periods seem to lead the radio ones by a few days.

Of course, Cyg X-3 gamma rays could instead be produced by protons. If the dense environment of a microquasar can seriously accelerate protons, as some have claimed, and if we had available adequate neutrino detectors, we could be facing a candidate for post-electromagnetic astronomy. Now, that would be real fun.

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PLANT SCIENCE

DNA Binding Made Easy

Daniel F. Voytas[1] and J. Keith Joung[2,3,4]

A mechanism by which proteins of bacterial plant pathogens recognize and control the expression of host plant genes to promote infection is identified.

All cells encode specific DNA binding proteins that ensure that genetic material is appropriately expressed, replicated, and transmitted from one generation to the next. Mother Nature solved the DNA recognition problem by inventing a handful of protein motifs, including the zinc finger, the helix-turn-helix, and the leucine zipper. As is the case with all good solutions to a problem, these motifs are used over and over again in biological systems; for example, DNA binding proteins containing the helix-turn-helix motif are found in both prokaryotes and eukaryotes, and zinc finger–containing proteins are the most abundant protein class encoded by the human genome. It is surprising, therefore, to learn from studies by Boch *et al.* (*1*) on page 1509 and Moscou and Bogdanove (*2*) on page 1501 of this issue, about a new DNA binding motif that has heretofore escaped description.

[1]Department of Genetics, Cell Biology and Development and Center for Genome Engineering, University of Minnesota, Minneapolis, MN 55455, USA. [2]Molecular Pathology Unit and Center for Cancer Research, Massachusetts General Hospital, Charlestown, MA 02129, USA. [3]Center for Computational and Integrative Biology, Massachusetts General Hospital, Boston, MA 02114, USA. [4]Department of Pathology, Harvard Medical School, Boston, MA 02115, USA. E-mail: voytas@umn.edu

The new motif plays a central role in the function of transcription activator–like (TAL) effectors, proteins expressed by bacterial plant pathogens of the genus *Xanthomonas*. TAL effectors are an important weapon in a battle waged between *Xanthomonas* species and their plant hosts. They are translated in bacteria and deposited into plant cells by the bacteria's type III secretion system. Once in a plant, TAL effectors activate the transcription of plant genes that enable pathogen spread. For example, PthXo1, a TAL effector of a *Xanthomonas* rice pathogen, activates expression of the rice gene *Os8N3*, allowing *Xanthomonas* to colonize rice plants (*3*). Because *Os8N3* is also necessary for normal plant development, the gene cannot simply be discarded to avoid infection. Rather, there is strong selective pressure for the plant to accumulate mutations that prevent PthXo1 binding, and, consequently, for compensatory changes in the TAL effector's DNA specificity. In the end, DNA recognition determines the outcome of the pathogen-plant war, and so TAL effectors would benefit from a simple, malleable mechanism for DNA recognition. Such a mechanism is revealed by Boch *et al.* and Moscou and Bogdanove in complementary studies that have deciphered the TAL effectors' DNA recognition code.

Both groups focused on the TAL effector's central domain, which contains a variable number of tandem, 34–amino acid repeats (see the figure). The repeat domain was previously shown to bind specific DNA sequences in promoter regions of target genes (*4*). Amino acid sequences of the repeats are conserved, except for two adjacent highly variable residues (at positions 12 and 13) that were obvious candidates for specificity determinants. Both groups deduced a simple code relating specific diamino acids in the repeat unit to specific nucleotides in the DNA target. Remarkably, there appears to be a one-to-one correspondence between sequential amino acid repeats in the array and sequential nucleotides in the target DNA.

Moscou and Bogdanove broke the DNA recognition code computationally, by searching for nonrandom alignments between the variable diamino acids in the TAL effector and DNA sequences of target promoters. For a handful of well-characterized TAL effectors, DNA sequences identified from the alignments were important for transcriptional activation, thus providing evidence that the alignments and the resulting code were biologically meaningful. Boch *et al.*, on the other hand, deduced the code through molecular genetic analyses of the interaction between AvrBs3 (the TAL effec-