Night club

Growing numbers of amateurs are getting serious about astronomy. The professionals applaud their enthusiasm and success in collecting data and building telescopes — as long as they don't start competing with them for funding. Geoff Brumfiel joins the graveyard shift.

“Growing up, I was one of those guys who wanted to be a rock star,” says Michael Koppelman. Shortly after he graduated from Boston's Berklee College of Music in 1988, the soft-spoken, hard-rocking Koppelman began a ten-year pursuit of his dream — working in recording studios with artists such as Prince and Booker T. and the MGs.

But his life took an unexpected turn when his girlfriend gave him a telescope for his birthday a few years ago. “I got the bug real bad,” he says. He began by imaging stars and galaxies, but gradually became interested in stars whose brightness changes over time. To monitor such ‘variable stars’ precisely required advanced equipment and expertise that Koppelman didn't have, so he began cruising Internet chat rooms, talking to others who were interested in doing more than just taking pictures of galaxies and planets. They were a motley bunch — from dotcom entrepreneurs to construction-equipment salesmen — whose passion for astronomy drove them to spend thousands of dollars on telescopes and cameras.

Extreme hobbyists can be found in any field, but with the help of cheaper technology, such as digital cameras and powerful personal computers, these amateur astronomers are beginning to take measurements that can rival those of the professionals. And the experts are taking notice: astronomers have begun tapping amateurs for their talent and telescopes, using them to detect asteroids, colliding stars and bursts of high-energy γ -rays from distant galaxies. Some amateurs are even turning semi-professional, offering their equipment

Garden variety: the amateur-run Tenagra Observatory has provided data for professional stargazers.

and services to full-time researchers for a price (see ‘Home help’, opposite). “The distinction between amateur and professional astronomers has become very fuzzy,” says Arne Henden, a professional astronomer at the US Naval Observatory in Flagstaff, Arizona.

Amateur army

Across the world, thousands of amateur astronomers point their telescopes skywards each night. Most are sightseers, scanning for colourful clouds of gas or spectacular spiral galaxies, but a few are interested in the more technically challenging aspects of astronomy. They join groups such as the American Association of Variable Star Observers, which since 1911 has enlisted the help of volunteers to monitor variable stars. There are tens of thousands of these stars — too many for professional astronomers to observe regularly — and logging their fluctuations is a full-time operation. Variable stars change brightness for many reasons:

they may pulsate or be eclipsed by a companion star, for example. For the brighter stars, all that an association member needs is a telescope and a reference star with which they can visually compare changes in brightness over several nights.

A small fraction of these amateurs take their measurements a step further. They buy advanced digital cameras and computer software that lets them count the light particles coming from the star at any given time. These more detailed measurements are exactly the type of data that Joe Patterson, an astronomer at Columbia University in New York, is looking for. Since the 1980s, Patterson has studied star systems in which a normal star circles around, and is sucked into, a much heavier object such as a black hole. Like variable stars, these star systems brighten and dim over the course of each orbit, but unlike most single stars, the high speed of the orbit means that the changes can take place in a matter of hours. This means that round-the-clock observations are needed to watch the star as it spins ever closer to its demise.

That's where the amateurs come in, says Patterson. Since the early 1990s he has enlisted the help of enthusiasts around the world to monitor these star systems 24 hours a day. It started with a few well-placed observers on the opposite side of the world from him, but gradually more have signed on, and Patterson's group — the Center for Backyard Astrophysics — now boasts some 40 amateurs from Utah to the Ukraine.

Among the centre's most prolific members is Berto Monard, based in Pretoria,

Key change: musician Michael Koppelman wants to swap chords for constellations.

South Africa. A metrologist at South Africa's Council for Scientific and Industrial Research, Monard became interested in stargazing when a friend at work introduced him to the hobby of spotting satellites as they sail by. "After a few evenings I got a bit bored with the satellites and started watching variable stars," Monard says. His obsession with precision measurements led him to take on even greater challenges, such as monitoring γ -ray bursts — short-lived emissions of high-energy radiation that are thought to be the violent explosions of dying stars. Such bursts of invisible γ -rays last for only seconds or minutes, although their visible 'afterglow' can last for hours, so speed and precision are of the essence, and a special challenge for the amateur connoisseur of cosmic events.

Home help

Some amateur stargazers are helping the professionals to cut the cost of building and running telescopes by offering them the use of home-made alternatives.

Tim Puckett, a construction entrepreneur turned amateur astronomer, has set up a company that builds 0.5-metre telescopes for a fraction of the retail cost. The design is based on Puckett's first telescope, which he built from scratch, and he has a patent pending on part of the design. Puckett, who already has clients in Canada, Italy and Ireland, says that this type of telescope retails for around US\$400,000, but boasts that he is "making the same 'scope for around US\$80,000".

Michael Schwartz, a retired software

Monard's observations of γ -ray bursts have won him international recognition. In July, while professional astronomers mingled at a conference in Australia, Monard was the first amateur to locate the afterglow of a γ -ray burst. Only a month earlier, he appeared as an author on a *Nature* paper detailing the complex structure of such afterglows (M. Uemura *et al.* *Nature* **423**, 843–844; 2003).

Making the grade

Monard's success shows that amateurs can gather top-grade data, but they are still outside the professional community — and that can cause problems. "I've been turned away by some professionals," says Tim Puckett, a retired construction-equipment salesman and amateur astronomer in Atlanta, Georgia. Puckett and his team search for supernovae, the explosions of dying stars. "They say that every supernova we find eats into their grant money," he quips. But in some cases, amateurs and professionals are now banding together to apply for funding. This sort of direct competition can cause friction, says Patterson, whose Center for Backyard Astrophysics has occasionally sought support for group members in developing nations to buy equipment.

For some professional astronomers in poorer countries, buying amateur-standard equipment is the only way that they can do any research. At the Torun Centre for Astronomy in Poland, astronomer Andrzej Niedzielski and his graduate student Gracjan Maciejewski are using a small telescope and a wide-angle camera to conduct a sky-wide search for variable stars. "To analyse the data we use professional techniques, but the hardware is strictly amateur," Niedzielski says. He also enlists a combination of students and amateurs (usually friends brought along for the evening) to operate his telescope. "You might call it a cheap source of labour, but these people like

observing," he says. Niedzielski hopes that eventually 10 or 20 stations around the globe can mount a massive all-sky search for variable stars.

Looking to the future, professional astronomers are planning ever more ambitious projects for their amateur cohorts. Tim Castellano, a planetary scientist at NASA's Ames Research Center in Moffett Field, California, hopes to use amateurs to spot Jupiter-sized planets crossing in front of distant stars. Observing these far-off eclipses requires exceptionally stable detectors and a great deal of skill, and professional astronomers have themselves only spotted one or two such events so far. Castellano believes there are only about 10 or 20 amateurs in the United States who have the right equipment and are up to the task. Training them will require lengthy one-on-one tuition, but Castellano believes the possibility of spotting many new planets makes it worth the effort. "The prize is large," he says.

Hunting planets and publishing papers sounds appealing, but there are limits to what amateurs can do and how fast they can do it. The Amateur Sky Survey, led by Tom Droege, a retired particle-accelerator engineer based in Batavia, Illinois, is a case in point. The project's ambitious goal is to use three digital cameras that are four-megapixels each in resolution to photograph the entire sky each night. But the group has struggled to find amateurs willing to write the software needed to turn images into hard data. As a result, the project has advanced more slowly than its collaborators would have liked, says Arne Henden, who works closely with the group. But the team has nevertheless managed to get almost a terabyte of data, Henden says — enough to fill 1,300 compact discs.

A more fundamental problem is that many amateurs are motivated by things other than science. The technical challenge of taking the data can be more exciting than the statistical analysis and theoretical interpretation needed to turn measurements into scientific papers. "I am not personally concerned with the academics," admits amateur Michael Schwartz of Patagonia, Arizona, Patagonia, Arizona, who runs the Tenagra observatory (see box).

But Koppelman, the reformed rock star, is interested in science. He has enrolled at the University of Minnesota in Minneapolis in the hope of gaining a PhD in astronomy. He knows he has a lot to learn, admitting that "I didn't even know what calculus was", but he is sure that he has what it takes to become a professional astronomer.

Koppelman isn't letting his ambitions get the better of him: while he pursues heady dreams of fame and fortune in professional astronomy, he hasn't given up the day job. "I still play guitar in a band or two," he says. ■

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developer, who made his fortune creating data-encryption programs for automated banking machines, has spent hundreds of thousands of dollars and countless hours putting together an 0.8-metre telescope complete with automated tracking and data-management systems.

Schwartz has begun selling telescope time to the professional community "just to see what happens". So far his customers are mainly based in the United States, but Schwartz believes that interest in his service could grow, especially in countries where researchers lack access to reliable medium-sized telescopes.

► www.observatoryscope.com

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