Astronomer Unearths Evidence of Scientific Tradition in Africa

Thebe Medupe, a rising star in South Africa's astronomy community, hopes his work will attract other young blacks into science and technology.

"Part of apartheid involved destroying people's aspirations," says Thebe Medupe, a South African astronomer. "Imagine being a black child and all the time reading about other peoples' histories and other peoples' way of doing things. You start having doubts about whether you played any role in human history."

Medupe grew up in a rural village in northwest South Africa. When he was 13, he built a telescope. "I remember the first night I pointed the telescope toward the Moon," he says. "It was amazing to see the craters, the valleys, and the mountains. Since that time I knew that my career was going to be in astronomy."

Today, Medupe, 32, who earned a PhD in physics at the University of Cape Town, is a researcher at the South African Astronomical Observatory. On top of his research on variable stars, Medupe explores cultural astronomy and historical scientific activity in Africa. In the 2003 documentary film *Cosmic Africa*, Medupe visits indigenous peoples across the continent to learn about the form and significance that astronomy takes in their cultures. His latest project involves scouring ancient manuscripts from Timbuktu, Mali, for references to science and math.

PT: How did you happen to build a telescope?

TM: When I was 13 years old, in 1986, Halley's comet was visible in South Africa in the night sky. Our school organized a theme around astronomy. That inspired me, so I went to our library and read a lot about astronomy. Eventually I came across a book on how to make a small telescope from things you can find at home. I used an old plumbers' pipe for the telescope. I borrowed lenses from our school. And I borrowed spray paint from our school workshop.

PT: How did you overcome poverty and racism to get where you are today—a professional astronomer?

TM: First and foremost it was my mother. She has been really my support and my inspiration in life. In spite of the fact that they were poor, my parents managed to send me to a very good school. It was integrated. We had people from all over the world, people of all colors.

We didn't have electricity or running water. But the night sky was beautiful, and every evening in summer we would go out and play, and sometimes sit around the fire with our grandparents to hear stories about the stars.

Also, I was born at the right time. Around the time I was going to university, apartheid was coming to an end. So all good universities in South Africa were opening opportunities for black people.

PT: What is your area of research?

TM: Asteroseismology. The main thing about the stars I study is that they are variable, their light output changes with time. That is because of the seismic waves—sound waves—that exist inside the stars. The ones I specialize in have strong magnetic fields. We use the sound waves generated inside these stars to try and learn about the makeup of the stars. We do spectroscopy to study phase velocity in these stars, or we use photometers to study the light-intensity variations.

We do the job with smaller telescopes, one-meter telescopes, because they are the easiest to get time on. And to avoid gaps in the data, gaps due to daytime, we get observations from different sites—Australia, South Africa, Chile.

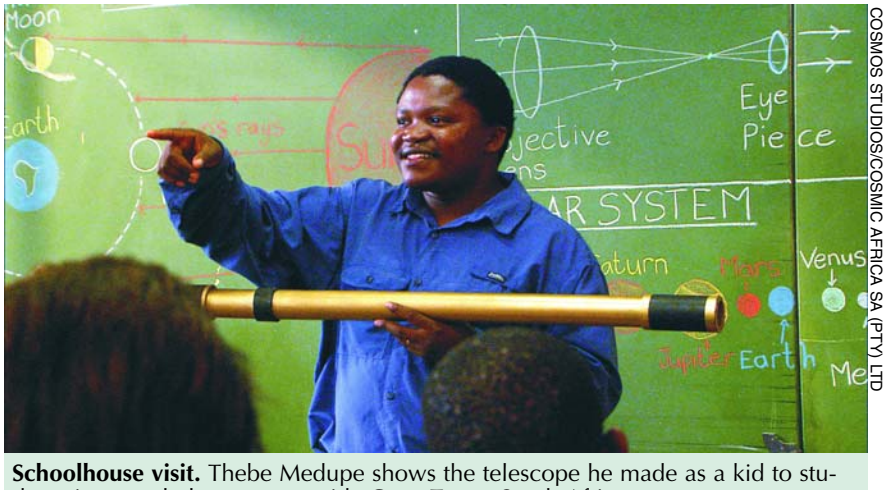
PT: Do you use the South African Large Telescope?

TM: My dream is to use SALT to study dark matter in the universe. One of the things I have been thinking about getting involved in is the search for dark matter using quasars. I'd be moving from studying individual stars—stellar astrophysics—to cosmology.

There are only about 50 professional astronomers in the country, and many of them are quite senior. We need more young people to get into astronomy, and we need them in areas that can best use the large telescope.

PT: How did you get involved in *Cosmic Africa*?

TM: Going back a bit, when I was 15, I started to question why everything was Eurocentric. Textbooks were using European things and so on. So I used to ask myself whether it was because there was nothing Africa can offer. I refused to believe that. It remained a very big question for me for a long time, until I came across a review on African ethnoastronomy. I was very excited. I was thinking of writing a book about that, when, about a year later, I was approached by a filmmaker and a journalist about



COSMOS STUDIOS/COSMIC AFRICA SA (PTY) LTD

Schoolhouse visit. Thebe Medupe shows the telescope he made as a kid to students in a rural classroom outside Cape Town, South Africa.

making a film.

We decided to select remote communities, where contact with the outside world was minimal, but also living communities where you could clearly and graphically show that astronomy was an important part of their lives. That's why we selected the Bushmen, who live on the border of Botswana and Namibia, and the Dogon people of Mali, West Africa. The Dogons still live the way they did 500 years ago. They were dignified, and very hospitable. At the beginning, it was not easy to get information from them—that's how they protect their culture from being eroded. But once we won their trust, it was very pleasant to live among them.

We also read about a stone observatory—stone structures in the Sahara desert in southern Egypt that were erected more than 6000 years ago; that's more than a thousand years before the Pyramids. The stones were erected to mark the directions of north and of the summer solstice sunrise.

I spent a week with the Bushmen, three weeks with the Dogons, and a week in the desert. It was amazing. It was fun, but it was also very harsh—temperatures were 48 °C.

PT: What's an example of how astronomy is important for the Bushmen or the Dogon people?

TM: One evening with the Dogons, I went with two old people to look at the stars. I asked them what was the most important constellation for them. They said the Pleiades, a star cluster, which is very important throughout the whole of Africa, actually. The stars are used for planting and agriculture. I asked this guy [for] positions of the stars, and he gave me the rising times and positions at different times of the year. I checked with my laptop, and he was very much correct. To me that proved he knew what he was talking about.

The Egyptian stones apparently contain alignments similar to those done a thousand or so years later at Stonehenge in Great Britain, but they are smaller in size. The Bushmen made out constellations just like the ancient Greeks and other peoples. To me, it shows the commonality between Africa and the rest of the world.

The whole point about the film is that this topic was never covered before. No one knew that African people were involved in this kind of thing, so it was very special for us. And it's a great message. You can tell kids that truly astronomy and the rest of science is a human activity, and it belongs to all of us. It makes it easy to attract young African children into science and technology.

J. KIM MALVILLE

This calendar circle, or cromlech, was made by nomads around 4800 BC. Other astronomical sites in the Nabta Playa region of the Sahara desert visited by Thebe Medupe in *Cosmic Africa* include multi-ton sculpted rocks arranged in lines extending over a half kilometer or so and oriented toward various bright stars.

PT: Do you do this sort of educational outreach?

TM: Yes. Because of the film, I get asked to visit schools and gatherings to interact with young people and to try to get them into science and technology. We have a great shortage of scientists and technologists in South Africa, generally. And the problem is even worse when we talk about black scientists and technologists. With the film, we hope to contribute to addressing that problem.

For example, we want to take the film to rural schools in South Africa. This model was used in England last year. I was invited to take the film there to motivate young black British kids to go into science and technology. I went to 20 schools over two weeks. We want to implement this here. After screening the film, you get a role model to talk to the kids, and select a group of them, maybe 30, and have a session on how to make a little telescope. They enjoy that a lot, because they get to use it and keep it.

I am also involved in a special program, called the National Astrophysics and Space Science Programme, which is hosted at the University of Cape Town. Every year I go and teach the theory of stellar structure at the master's level for one month. It's an intense course. We are trying to increase the number of people with a master's or PhD in astronomy. It's for everybody, but we try to make things as representative of the South African population as possible—South Africa is 80% black.

PT: What's your next project?

TM: In addition to continuing my studies in astronomy, one of the projects I am very excited about is on Timbuktu. It was one of the major cities of West Africa from 800 until just over 400 years ago. It was very prosperous, and had many learning centers, with people collecting and writing books on law, poetry, astronomy, optics, mathematics. This history of scholarship in Africa extended over large parts of the continent. Ancient manuscripts are found all over West Africa and even in East Africa. They are written in Arabic and in local African languages.

These books have resurfaced in government and private libraries. In Mali alone, there are around 200 private libraries, and literally hundreds of thousands of books.

The project I am working on is a search for astronomy books in this collection. It's very exciting—it shows that science didn't come to Africa 200 years ago with colonization of the continent. There were always places where science was taking place, even before in Europe.

PT: Have the manuscripts been studied by others?

TM: Yes, for example, a professor from Northwestern University has been studying Islamic texts from western Africa. He was not searching for science specifically, but by coincidence he has found a very interesting recording of a meteor shower in 1583, written in the margins of one of the books. So these texts potentially contain a lot of interesting things. Some of it could be recordings of astronomical events, some of it could be explanations of how people determined the Qibla, the direction of Mecca, and all kinds of aspects of Islamic astronomy, Islamic mathematics, and so on.

Our effort is the first to search specifically for science in these

manuscripts. A team of five of us, including a historian, another astronomer, a mathematician, and a photographer, will be doing this in conjunction with a team of scholars in Mali itself. The idea is to reconstruct the status of scientific research at the time when Timbuktu was at its peak, and to document that and make it accessible to universities and schools, so our people can take pride in knowing that their ancestors were interested in science.

For me, all I need to find to make me very proud is to show definitely that these people were aware of what was going on—that they were aware of the hottest topics in astronomy of the day, the same as other scholars everywhere. **Toni Feder**

For information about purchasing a DVD of the film *Cosmic Africa*, e-mail alandpics@mweb.co.za. Write "Buy Cosmic DVD" in the subject line.

To Redefine Kilogram, Experiments Must Weigh In

Once a discrepancy between experiments disappears, the definitions of the kilogram and three other units will be updated to keep pace with scientific measurement capabilities.

The measurement of mass is due for a makeover, pending convergence of two experiments. That consensus was reached last October by the International Committee for Weights and Measures, and the kilogram—along with the ampere, kelvin, and mole—could be redefined in terms of fundamental constants as early as 2011.

"One has to go back to the original definitions of the meter and the kilogram at the time of the French Revolution," says Terry Quinn, emeritus director of the International Bureau of Weights and Measures (BIPM), located outside Paris. "What they wanted to do was to have some unit that was universal, available to everyone, and not based on the length of the king's arm." A century later, in the late 1800s, following the rise in trade and manufacturing, industrial nations formalized definitions for weights and measures, he adds. Since 1889, the international standard kilogram has been a cylinder made of a platinum–iridium alloy and housed at the BIPM.

In the meantime, the second has gone from being a fraction of a day to being linked to the period of a hyperfine transition of cesium. And the meter has progressed through being a fraction of the Paris meridian, the length of a reference bar, and the wavelength of a transition of krypton to the current definition, set in 1983, as the distance light travels in a vacuum in 1/299 792 458 of a second. Indeed, the kilogram is the only unit in the International System of Units (SI) still based on a material artifact. By comparing the international standard to national copies, says Richard Davis, head of the BIPM mass section, "we estimate the mass has changed by about 50 parts per billion [ppb] over 100 years." Adds Quinn, "We want to have our reference standard better than that—units need to be defined to at least the precision with which measurements can be made. It's not a matter of whether to redefine—it's really a matter of what's the timing."

Exact constants

A proposal early last year by Quinn and four others to move ahead immediately met with opposition in the mass metrology community. "If the kilogram were redefined prematurely, before experiments attain sufficient uncertainty, I think we would have problems," says Michael Gläser of Germany's national standards lab in Braunschweig. In particular, the value of the kilogram might have to be tinkered with.

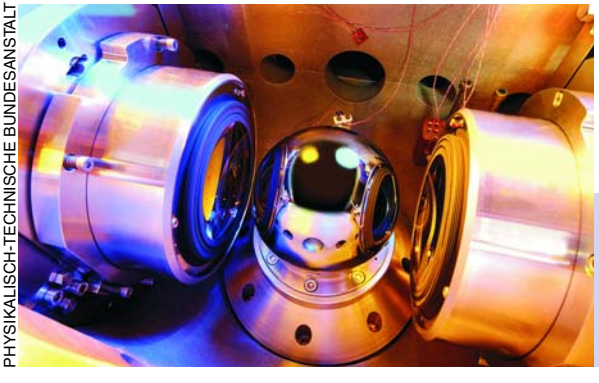
In an article in *Metrologia* this spring, Quinn and his coauthors widen their proposed SI overhaul. They favor redefining the kilogram so as to fix the Planck constant h to an exact value, although linking it to the Avogadro constant N_A is also an option. They would also redefine the ampere to fix the elementary charge e, the kelvin to fix the Boltzmann constant k, and the mole to fix N_A. The new definitions would shunt the un-

BIPM/INTERNATIONAL BUREAU OF WEIGHTS AND MEASURES

The international prototype of the kilogram is 39 mm in diameter and 39 mm high. This is a copy of the actual reference standard.

EDWIN WILLIAMS/NIST

The moving-coil watt balance at NIST holds the record for relating a mass standard to the Planck constant. Of five such experiments worldwide, it's the only one that uses superconducting magnets.



PHYSIKALISCH-TECHNISCHE BUNDESANSTALT

A 1-kg silicon sphere used for counting atoms is set up here to have its roughly 92-mm diameter measured interferometrically.