Report from Africa

Space as a Driver For Development

by Marsha Freeman

Oct. 9—For the first time in 62 years, the annual Congress of the International Astronautical Federation (IAF) was held on the continent of Africa. More than 2,000 scientists, engineers, and students, including hundreds from more than half of Africa's nations, traveled to Cape Town, South Africa to discuss the latest developments in space science, technology, and applications over the week of Oct. 3-7. There is no continent, many speakers emphasized, facing greater challenges than Africa. And no continent where space technology could make a more dramatic positive difference to the future.

Although South Africa is the most economically developed and scientifically advanced nation in Africa, all of the speakers from the host country stressed that the Congress was being held for the benefit of, and by invitation of, all of Africa. At the opening ceremony of the Congress, Dr. Sandile Malinga, head of the South African National Space Agency (SANSA), extended his welcome "from the heads of the space agencies of Africa." Although South Africa itself has had space science and astronomy efforts going back decades, and more than a decade of space technology development, SANSA itself is only six months old. South Africa is in the process of gaining approval of a multiyear plan.

At present, a number of African nations are using data from space-based Earth-orbiting satellites to bring a scientific dimension to decision-making for building transportation infrastructure, monitoring agriculture, assessing water resources, recovering from natural disasters, tracking disease, and other applications. A handful—principally, South Africa and Nigeria—are working towards building their own satellites, to develop an independent and more affordable alternative to hardware and software from abroad, and to be able to tailor satellite technology to their specific needs. Multination science projects are underway and are being planned to develop Africa's scientific and technical manpower, and to contribute to global scientific achievements.

An Earth-Observing Constellation

Africa, the second-largest continent in area, has a population of about 1 billion people, the majority of whom live without the most basic economic infrastructure, including electricity, transportation, clean water, and adequate education and health care. National leaders are looking toward the use of data from Earth-orbiting resource-monitoring satellites and space-based communications capabilities for problem-solving. All of the speakers stressed that this can only be done effectively through a continent-wide effort.

The week before the IAC conference, Mombasa, Kenya hosted the 4th African Leadership Conference on Space Science and Technology for Sustainable Development. The timing was not coincidental; the theme of that conference was "Building a Shared Vision for Space in Africa," and was preparatory to the discussions the following week in Cape Town. The government leaders at Mombasa declared their commitment to extend and broaden Africa's participation in, and utilization of, space science and technology.

In 2009, Algeria, Nigeria, Kenya, and South Africa established the Africa Resource Monitoring Constellation (ARMC), to consist of four micro-satellites tasked with Earth observation, from which data would be freely shared among the members. At the IAC Congress, representatives from the ARMC nations explained why, with the dozens of Earth-observing satellites already in orbit, an African constellation is necessary. From the practical standpoint, the head of SANSA, Dr. Malinga, explained, it takes nine days for one satellite to cover the entire continent. This is grossly inadequate to monitor changes in real time, such as disasters, the spread of crop disease, changing water resources, and many other factors. With a constellation of four satellites, optimized for African coverage, he said, 1,000 images a day can be taken.

During the last session of the week-long Congress, Konrad Wessels, principal researcher, Council for Scientific and Industrial Research of South Africa, cited the importance of data becoming more affordable to Africa's decision-makers, farmers, and citizens. "It would cost $40,000 to buy three images" of Africa from foreign commercial companies, he said. With an African system, the data will be free.

Dr. Seidu Oneilo Mohammed, head of the National Space Research and Development Agency of Nigeria, expressed the problem as "more than $100 billion of 'capital flight' to buy services" abroad, in order to have access to and utilize space data. Nigeria's goal, he said, is to reduce that by 50% in the next ten years, by creating its own capabilities, which will "create jobs and social stability." Nigeria's five-year road map is to work with partners in satellite building and systems, then increase the local input for the satellites, and later, build satellites themselves.

So far, Algeria, Nigeria, Angola, and Egypt have operating Earth-observation satellites. The week before the Cape Town congress, Malinga announced that the South African space agency will ask the government to fund the design and construction of a South African satellite, to join the Constellation. He cited the need to reduce the country's "high-technology trade deficit," stressing that the project would also excite South African youth. The new satellite is estimated to cost in the range of 400 million rand (more than $55 million), which is more than ten times the cost, and capability, of their previous Sumbandila prototype Earth-observation satellite.

So far, South Africa has taken the lead in developing the skills to design and build its own satellites, which requires creating an entirely new space industry. "No leader in the world has succeeded in developing [his or her country] without improving [its] manufacturing capacity," observed Prof. Henry Kaane, Secretary of Higher Education, Science, and Technology in Kenya. He cited India, China, and Korea as examples. As is true in every space-faring nation, the exacting demands of space technology raise the skill, technology level, and productivity throughout the economy.

With this initiative, Africa will be able to develop the capabilities *in Africa* to collect data from satellites, interpret data to create useful information, learn how to design, build, and operate satellites indigenously, and, in the future, launch them from African soil. Each step of this progression requires the acquisition of increasingly complex and advanced science, engineering, and manufacturing skills.

A World-Class Science Project

South Africa has more than a 70-year history in world-class space science projects. Its telescopes are the prime facilities for looking into space from the Southern Hemisphere. These include the Hermanus Magnetic Observatory, which takes advantage, through continent-wide collaboration, of the fact that the Earth's magnetic equator passes through the middle of Africa. The magnetically quiet environment of the observatory is protected, as the scientists measure minute changes in the magnetic field of the Earth, and the effect of solar activity on our space weather.

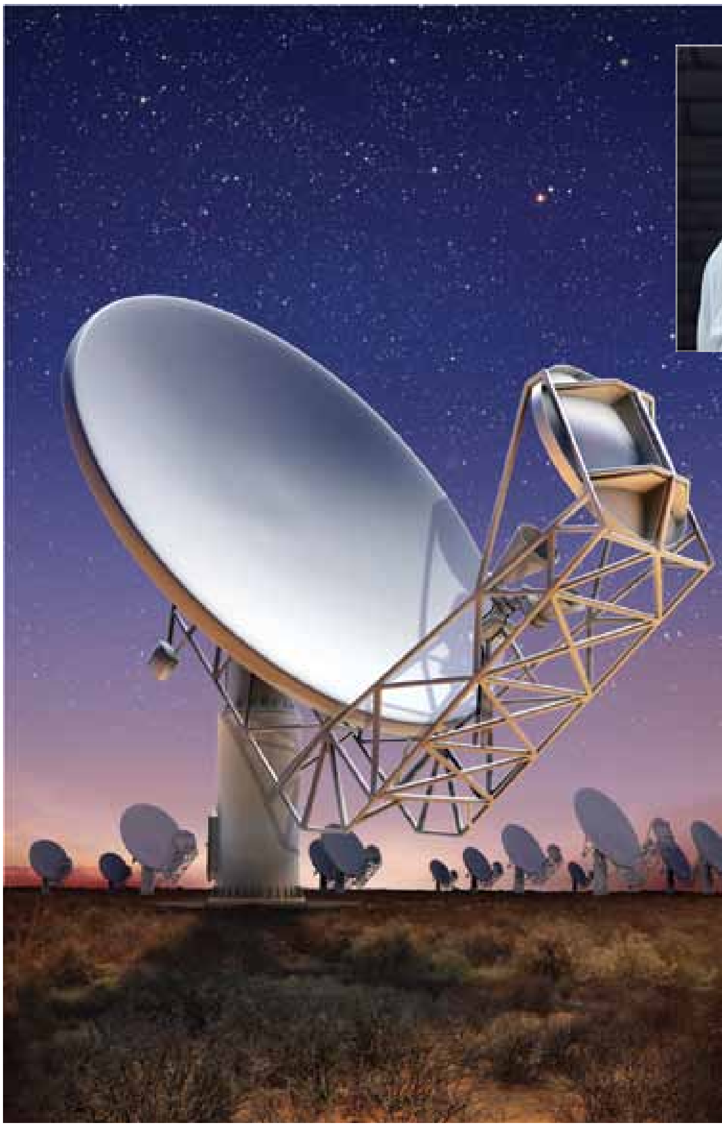
Dr. Lee-Anne McKinnell, of SANSA Space Science and director of the Observatory, explained at the Congress, that through her program, students from throughout Africa are being trained, with exchange visits among students from Kenya, Nigeria, and Zambia. The Hermanus Observatory has been leading the effort to collect geophysical data in Africa, the science of which was largely unknown on the continent until recently. The South African Astronomical Observatory and the Hartebeethoek Radio Astronomy Observatory are operated by the National Research Foundation of South Africa.

South Africa has recently undertaken a very ambitious project to build 64 radio astronomy dishes in an array, to be completed between 2016-17. The first telescope dishes of the Karoo Array Telescope, or MeerKAT, are now being tested to be commissioned. When complete, MeerKAT will be the most sensitive radio telescope in the Southern Hemisphere, and the second in the world.

The project has required new, cutting-edge technology. For this reason, although scientific observations will not begin until 2016, some 500 astronomers worldwide have already applied for time on the telescopes. Even South African post-graduates currently in the United States plan to come back to do advanced research, Dr. Bernie Fanaroff said at the Congress.

But MeerKAT is seen as a "dress rehearsal" for a truly gigantic project the scientists hope will rewrite what we know about the cosmos. At the Congress, Dr. Fanaroff announced that on Sept. 15, the final proposal was submitted by South Africa and eight other African nations to the international astronomy community, to build the Square Kilometer Array (SKA) radio astronomy project in South Africa. To demonstrate its support for this enormous and highly ambitious project, the South African government created a special cabinet position for SKA. Fanaroff is the project manager.

South Africa is well situated as the site for the project, Fanaroff explained, as it created a "radio astronomy reserve," through the North Cape Province As-



SKA Africa

South Africa has recently undertaken the ambitious project of building 64 radio astronomy dishes in an array, to be completed between 2016-17. The first telescope dishes of the Karoo Array Telescope, or MeerKAT (shown in this artist's conception), are now being tested. Inset: Dr. Bernie Fanaroff is the project director.

SKA Africa

tronomy Geographic Advantage Act, which prohibits any activity that would interfere with radio astronomy. Internet connections are only fiber optic, for example. And no cell phones.

The SKA will consist of up to 3,000 radio astronomy dishes which could be spread all over Africa, over thousands of kilometers. The farther apart they are, the higher the precision of the observations. The partners with South Africa in the bid for the SKA project are Namibia, Ghana, Kenya, Madagascar, Mauritius, Mozambique, and Zambia, and it is hoped that each would host stations, with the South Africa site at the core. The SKA is designed to be 50 times more sensitive and 10,000 times faster in data processing than the best radio telescope today. It is estimated that it will cost about $2 billion to build, funded by a U.K.-based consortium which could be made up of about 16 nations. The SKA should be in operation by 2024.

The African nations preparing the proposal for the SKA have worked on it since 2003, with about 100 young scientists and engineers working on the proposal in the Cape Town office. Fanaroff is especially proud that 300 grants for studies and 5 university research chairs have been created in South Africa through this proposal preparation process. There have been 25 PhDs and 52 Masters degrees granted, on the basis of research done on the project. And astronomy is now being taught in Botswana, Ghana, Kenya, Mozambique, Madagascar, Mauritius, and Zambia.

Most important, Fanaroff believes, is that the project has "raised the science and technology profile" in South Africa, and also in Europe and other countries," which now see "that Africa can do cutting edge science and technology."

Africa's only competitors for hosting the SKA project are Australia and New Zealand.

The decision on which site will be chosen will come early next year. Fanaroff was asked in a Congress session, what if Africa is not chosen for the SKA? And how could he justify the amount of money that will have to be spent?

We will complete MeerKAT, he replied, and "do world-class science for 50 years" using that facility. "We will do remarkable science" by also expanding the use of other telescopes in Africa, and "we will play a leading role in SKA, no matter where it is built."

"There are short-term problems" in Africa, he responded, "but we can't limit ourselves" to those. Astronomy is "inherently a very exciting subject.'We are creating the cadre who are transforming the way Africa sees itself, and is seen around the world."