# 'A Brightly Shining Star': Susan McKenna-Lawlor

*There is a small number of women space scientists, fewer yet who run their own space technology company. Marsha Freeman interviewed this extraordinary Irish scientist at a European conference.*

*Susan McKenna-Lawlor is an astrophysicist, born in Dublin. She is Emeritus Professor at the National University of Ireland, Maynooth, and the founder and director of Space Technology Ireland, Limited. She has been a Guest Professor at the Chinese Academy of Sciences, and has participated in space science missions launched by the world's major space agencies. She has been a principal or co-investigator for instruments she designed, built, tested, and flew in space, and she has authored or co-authored more than 100 academic contributions on scientific and technical subjects, as well as on the ohistory of Irish science.*

*During her career, Dr. McKenna-Lawlor has received many honors including the Russian Tsiolkovsky Gold Medal for Outstanding Contributions to Cosmonautics (1988), the Irish Person of the Year Award (1986), Irish laureate Woman of Europe Award (1994), and Book Award of the International Academy of Astronautics (1998).*

*More impressive than her list of academic credentials, however, is McKenna-Lawlor's insatiable thirst for knowledge, interest in a wide range of scientific questions, good humor, and dedication to education, particularly in Ireland.*

*This interview was conducted on Oct. 6, 2003, following the Congress of the International Astronautical Federation, in Bremen, Germany.*

**EIR:** How did you become interested in science and decide to become a physicist?

**McKenna-Lawlor:** My backround, prior to going to the University, was completely non-scientific.

When I was growing up, it wasn't really considered proper for a young lady to study science. It was, in fact, deemed to be unfeminine, and there was intead a great emphasis on what one might call "the polite subjects." We studied music, drama, poetry, history—all of those beautiful things—but there was no physics, chemistry, or anything of that kind in my life.

When it came time for me to leave school and go to the university, there were two ways to qualify for entry. One was to take what was called the "intermediate certificate" examination, and the other was to sit for the "leaving examination." The first took one year of concentrated study and the second, two years. I opted to sit for the intermediate certificate, and passed it. Therefore, I was in a situation where I had, in effect, gained a "study-year."

I went down to the University's Admissions Building to find out what was on offer, and it was expected by my teachers that I would opt for a career in music, or, maybe, in history. However, music was considered to be the more likely choice. Being me, while I was there, I collected everything that was available—you have seen me at the IAF; I can't leave any book or paper behind—and that time, I loaded into the saddle bag of my bicycle not only brochures concerning the humanities, but also those from the science faculty. These I read at home, and immediately came upon a lot of words that meant nothing to me—quantum mechanics, thermodynamics, etc.

It seemed as I read on, that if civilization rested on the twin pillars of the arts and the sciences, I was decidedly skewed. I

*Susan McKenna-Lawlor is seen here holding a model of a spacecraft, during a recent visit to the Mahne Siegbahn Laboratory in Sweden.*

therefore decided that it would be sensible to use the year I had gained to try to balance my education and learn something about the mysterious world of science. Thereafter, I would go back to topics I knew something about.

I conveyed this to my parents. They were very surprised, but said, "If that is what you want to do, we will help." My mother and I then went down to the University, where I was given permission to enroll for the science course.

**EIR:** Why did you need permission to enroll?
**McKenna-Lawlor:** Because I was too young.

I started the course, and I found myself in a very different world. There were a lot of boys there who seemed to me to have "honors" in everything scientific. Meanwhile, there was I, knowing nothing at all. Initially, I was quite overwhelmed by the acids boiling in test tubes and all of the unfamiliar equipment in the laboratory.

Indeed, on the first day I saw all of that, and went home and wept. My father said, "Why are you worrying? Just go back to your music." But I said, "Oh, no. This is a challenge I have to meet." Then, not very long afterwards, I was sitting on my bed—where I liked to study—with my books around me, and suddenly I had a kind of "road to Damascus" experience. I suddenly realized that the material I was studying was filled with beauty that transcended anything I had experienced before. I decided that if I could possibly keep up with this course, I would like to be a scientist. Now, many years later, I can say that that magic and excitement I felt on that day, have never left me.

**EIR:** What were you most interested in? What area was your degree in, when you graduated from the university?
**McKenna-Lawlor:** I read for a general degree in science. Then, I specialized in experimental physics. I went on to take a master's degree and a Ph.D.

**EIR:** What had you planned to do when you left the University? Were you planning to teach?
**McKenna-Lawlor:** It was all decided for me, really, because I was looking into a microscope one day, when the door opened and the professor of experimental physics came in and said: "I have recommended you for a scholarship to the Astronomical Section of the Dublin Institute for Advanced Studies. Will you take it?" If he had said, "Will you go on a trip to the Moon?" I could not have been more surprised. I said, "Professor, I know nothing about astronomy." And he said, "I know that. Will you take it? People are waiting." I tried to gain time, and said, "But do you think it's a good idea, given that I know nothing about the subject?" To this he answered very testily, "Of course I think it's a good idea. I suggested it."

In those days, people completely respected and trusted in their professors, so I replied, "If you think it's a good idea, then I will do it." "Good," he said, and turned on his heel and went out of the door, and it was as if he had never been there. Yet my whole professional life was decided in that moment.

**EIR:** What did the scholarship entail? Was it to do observational astronomy?
**McKenna-Lawlor:** At that time, the Director of the Dublin Institute Astronomical Sector was a very distinguished man, named Prof. Mervyn Ellison, who was World Reporter on solar activity in the International Geophysical Year [1957-58]. That meant that he was involved in the global organization of the International Geophysical Year, and his activities included setting up, at the Cape of Good Hope, a solar telescope, with the capability to observe the Sun in the H-alpha line. This telescope recorded activity on the Sun including flares and other transient phenomena, and the movies made at the Cape were routinely forwarded to the Institute in Dublin.

Further, because of the personal prestige of Professor Ellison, our Observatory created what was called a World Data Center. So together with the films from the Cape, information was sent from interdisciplinary sites all over the world to

Dublin, for assessment and interpretation. Thus, I had the very great privilege of being trained by Professor Ellison in the analysis of an extremely wide range of scientific data.

Unfortunately, the Professor died rather early in his life, but not before he had introduced me to a distinguished American colleague, Prof. Helen Dodson Prince, from the McMath Hulbert Observatory of the University of Michigan at Ann Arbor. In those days, the McMath Hulbert Observatory was a very eminent solar analysis center, and I came to spend some happy years there, working for my Ph.D.

While I was at Michigan, there was great concern that the radiation associated with solar flares might prove to be lethal to NASA's astronauts. Indeed, many of them came to the McMath Hulbert Observatory to learn about solar flares and the biological hazards associated with them. Thus, as a very young girl, I addressed trainee astronauts on this topic.

As a result of my experience in Michigan with NASA's programs, when I went home to be married in Ireland, I was anxious to continue with space research, although we did not then have available in our country the laboratory facilities required to support this.

Meanwhile, I accepted a post at what was then called St. Patrick's College Maynooth, part of which is now styled the National University of Ireland at Maynooth; and there, I lectured in the Experimental Physics Department while working on two space programs. One of them was NASA's Skylab mission and the other the Solar Maximum Mission.

Thereafter, I was encouraged to propose an experiment for the European Space Agency's Giotto Mission to Halley's Comet, to be launched in July 1985. People in Europe were very excited about Giotto, which was [the European Space Agency's] ESA's first mission into deep space, and there was *tremendous* competition in Europe for one of the ten places on board the Giotto mission.

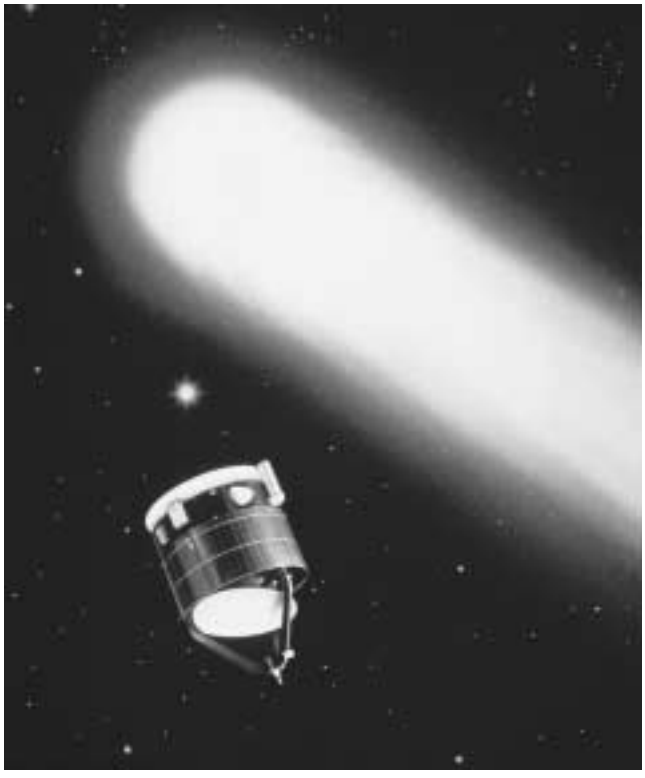
**EIR:** Do you mean competition for a place for a scientific instrument?

**McKenna-Lawlor:** Yes, for a scientific experiment to fly on spacecraft Giotto to Halley's Comet, which is, of course, an object with an enormous emotional attraction for the whole human race.

**EIR:** Not to interrupt, but a dear friend, Dr. Robert Moon, who worked on the Manhattan Project, was thrilled to have seen Halley's Comet twice during his lifetime.

**McKenna-Lawlor:** My mother also saw Comet Halley twice. First when she was a young girl, and then, in 1986, when it came around again, I brought her out to see it and she was very excited to have that second opportunity.

In the matter of getting an experiment aboard Giotto, I first formed a team to make a proposal to the ESA to fly what came to be the first Irish experiment on an ESA mission. After vigorously defending the scientific and technical rationale of this proposal, I was very pleased when our group was selected to fly our experiment. I called the instrument after a Celtic goddess who is associated with the commencement of the solar year. Her name is Epona, and it also was an acronym for Energetic Particle Onset Admonitor—so the name also tells you what the instrument did.



*Europe's* Giotto *spacecraft to Halley's Comet was the first of its deep-space missions. Susan McKenna-Lawlor flew the first Irish space science instrument on board, named* Epona, *after a Celtic goddess.*

This name is very important within Ireland because everyone knew about the goddess Epona, and all were delighted that our ancient Celtic heritage was associated with an historic space mission at the very frontier of technology.

We built the engineering model of the Epona instrument in Germany because, at that time, we did not have at our site, the clean room and sophisticated testing facilities required for such an activity. During this first period, my engineers learned at the Max Planck Institute at Lindau, Germany, through the kindness of its then-Director Professor Axford, those special techniques that must be used when preparing an instrument to function in the hostile space environment. Meanwhile, in parallel, I managed to install at the University the equipment required to construct the flight model, so by the time the overall design had been validated by means of the engineering model, the flight model could be built in Ireland. That was the first space experiment for which I was the PI, or principal

investigator. That title implies that the PI carries responsibility for the scientific, technical, and also the administrative aspects of the experiment.

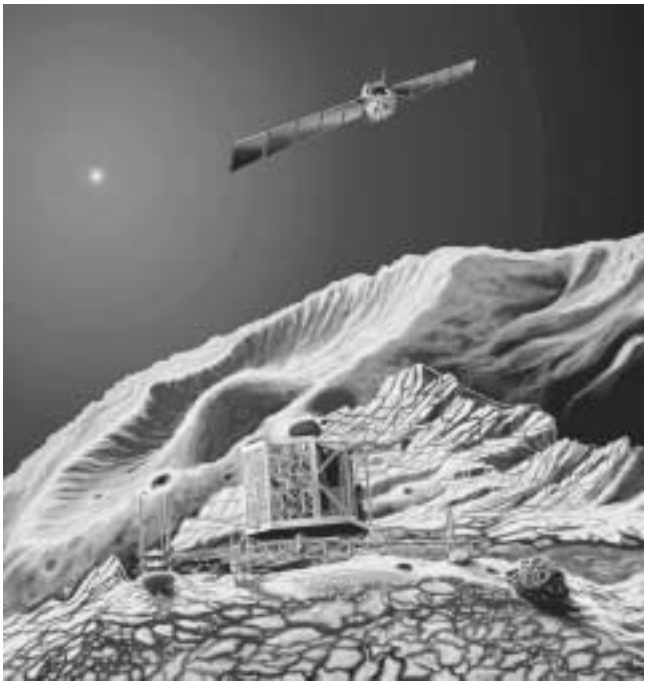
Giotto was a very successful mission, and it turned out to have a great richness, because not only did the spacecraft fly to Halley's Comet; but, thereafter, when it was decided to command Giotto on to another comet, (Grigg-Skjellerup), associated maneuvers provided the first historic occasion when a working spacecraft coming from deep space encountered the Earth.

Giotto was [the] a working spacecraft, because my instrument and the magnetometer from Germany were both making observations during the Earth fly-by. This was possible because both instruments had onboard memories, and were able to store data while out of touch with ground control during the encounter. Epona accordingly secured a unique dataset when close to the Earth. After that, the spacecraft proceeded on to the next comet where further pioneering measurements were taken. All of that was tremendously rewarding and exciting.

Meanwhile, I was invited to build an instrument that would go to Mars and its moons on Russia's Phobos mission. This was also an energetic particle detector, called SLED, this time designed to operate in the close-Martian environment.

**EIR:** Were you still at the University at this time?
**McKenna-Lawlor:** Although I remained on at the University, I had, by that time, formed a company, Space Technology Ireland, Limited. At the end of the Halley encounter, there was a tremendous interest in our participation. I realized that if we were to build upon what had been achieved, we would need to have more robust financial backing than is typically available in an academic setting. I was advised to approach an Irish businessman, Dermot Desmond, who is a great philanthropist, and I went to see him shortly after the Halley fly-by—that is, before Giotto went on to its two other targets.

**EIR:** What year was that?
**McKenna-Lawlor:** That would have been at the end of 1986. The Halley's Comet encounter was in March 1986. I told Mr. Desmond that if we were to capitalize on what had been achieved, and proceed to provide high-technology jobs within Ireland in the space industry, a commercial company should be formed. He agreed that this should be done, and provided a building in which the company's work could be carried out. He also made available the resources to send a number of engineers to Europe for special training, and in addition, he bought some sophisticated electrical and test equipment. Finally, he provided me with a financial advisor. "You are an academic, and otherwise you will go bankrupt!" he told me. I had the advantage of being formally trained in the difficult business of running a company. A few years later, when everything was up and running, he said, "Now I am going to sell the company to you and the responsibility for it will be yours." And that is the situation that I have today.

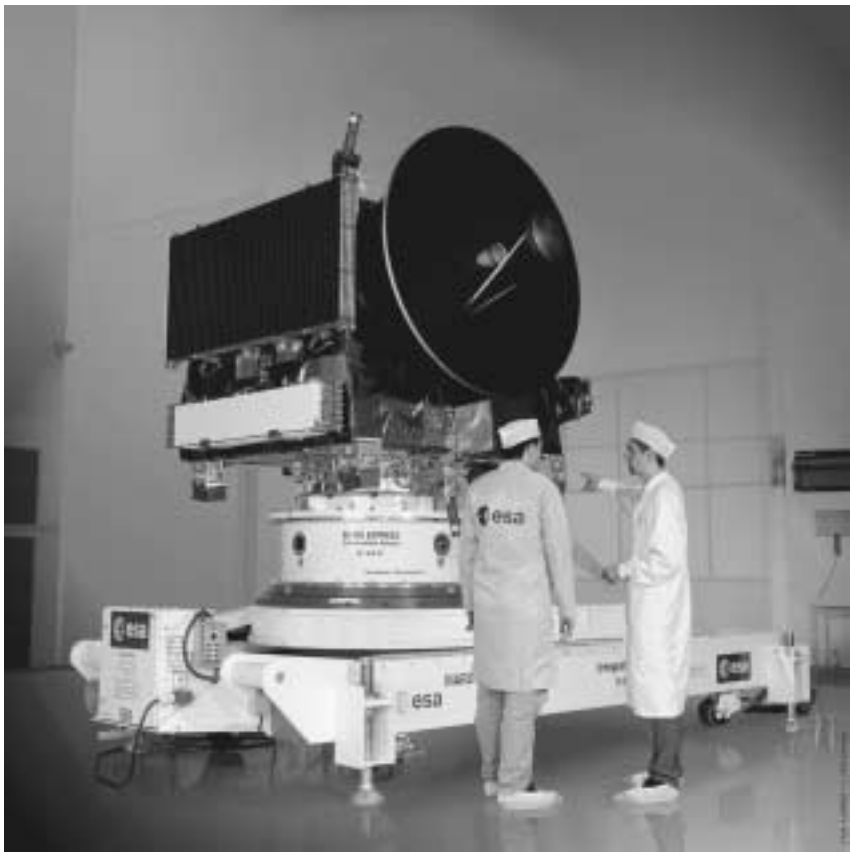


*The Rosetta mission will involve an orbiter and a small lander on the surface of a comet. Space Technology Ireland, Ltd. is providing the electric support system, which is critical to the mission's success.*

**EIR:** What missions has Space Technology Ireland participated in since then?
**McKenna-Lawlor:** We have built a lot of instrumentation, both experiments and subsystems, for missions flown for the various major space agencies. Also, we apply spinoff technology to ground-based problems in the automotive, medical, and other commercial areas.

For the ESA, we built, or participated in building instruments for SOHO, Cluster, Cluster II, Mars Express, Rosetta, SMART-I, and Venus Express. For NASA we built instruments for the WIND and Gravity Probe-B spacecraft, as well as for one of the Shuttle missions. For Russia, we built instruments for the Phobos and Mars '96 missions. We were also involved in the construction of an instrument for the Japanese mission, Geotail, while another is just about to be delivered on a Chinese mission, called Double Star.

**EIR:** What is Double Star?
**McKenna-Lawlor:** That mission is the result of an agreement between the European Space Agency and the Chinese space agency, that China will provide two spacecraft that will




Mars Express, *seen here being integrated, is scheduled to land on the red planet on Christmas Day. Susan McKenna-Lawlor is a co-investigator on the ASPERA instrument, to study solar-related disturbances near Mars.*

scientifically support ESA's Cluster II mission. Cluster II is composed of a constellation of four spacecraft that fly in different formations and study geospace. One of the Chinese spacecraft will fly in an equatorial orbit and the other in polar orbit. I am a principal investigator for the Irish experiment NUADU that will fly on the polar-orbiting spacecraft. NUADU is designed to monitor the interaction between the solar wind and the Earth's environment.

This year, I am involved in a lot of activity in space, including the launch of Mars Express and SMART-1. In the case of Mars Express, I am a co-investigator on the ASPERA experiment, which will monitor solar-related influences in the close-Martian environment. For SMART-1, I participated in the SIR experiment, which will study the nature of lunar rocks.

Early next year, the launch of Gravity Probe-B is expected. This is also sometimes called the relativity mission, because it will challenge two of the predictions of Albert Einstein's General Theory of Relativity. One is about the warping of space-time and the other concerns the way that the Earth drags space-time around with it. My company has provided a sophisticated, custom-designed particle detector with the capability to provide ongoing monitoring of energetic particles along the spacecraft trajectory.

In the coming year, we also will have the launch of the European Space Agency's Rosetta mission, which will land a sophisticated laboratory on the nucleus of a comet. Space Technology Ireland built the state-of-the-art electrical support system processor unit for Rosetta, which will store, transmit, and provide de-coding for the command streams passing from the spacecraft to the lander while it is on the comet nucleus. It will also handle the data streams coming back to the spacecraft from the various scientific experiments on the lander. The electrical support system is mission-critical, because a success of the lander depends on the successful acquisition of scientific data from the comet nucleus. During the cruise phase to the comet, the command and data streams passing through the umbilical connector of the lander to Rosetta's onboard computer will also be handled by the electrical support system.

**EIR:** You started out in solar physics, but you have branched out into studying most of the Solar System. Have you continued your research in solar physics as well?

**McKenna-Lawlor:** I'm looking at a broad picture, in the sense that planetary, cometary, and even asteroid exploration is included, but I have, by no means, forgotton my solar roots. For example, the Irish instrument LION, which was built by my company, is presently on board the SOHO, or the Solar Heliospheric Observatory, which is at the L1 Lagrangian point, continuously taking pictures of the Sun. LION is studying the interplanetary shocks and energetic particles associated with ongoing solar activity. In this connection, it has recently been very interesting to me to compare the predictions of numerical models of various traveling shocks and energetic particles with the data actually recorded at L1 aboard LION/SOHO and then at the Earth itself—where the arrival of such space weather produces profound disturbances. To validate the predictions is important because they provide early warning of events that can potentially cause problems in the functioning of Earth-based commercial equipment, such as electric power grids, communications systems, and geological surveys, and also potentially problems aboard orbiting spacecraft and the International Space Station.

When Mars Express reaches Mars, the numerical simula-

tions will be extended to predict solar-related disturbances in the near-Martian environment. These continuously updating predictions will then be checked against the observations made aboard the spacecraft by the ASPERA instrument, for which I am a co-investigator. Such observations can tell us not only about the changing radiation environment at Mars, but, in parallel, provide information of importance in designing future manned missions to the planet.

I already have very interesting data recorded by our SLED instrument on Russia's Phobos mission, which measured particles with energies greater than 30 million electron volts over a period of more than 10 days in the close vicinity of Mars. This kind of intense radiation must be taken into account in plans to establish a habitat there.

**EIR:** It was my understanding that the Phobos mission returned very little data. I know the first spacecraft failed during flight, before it reached Mars, and that the second reached Mars in January 1989, but did not function very long.

**McKenna-Lawlor:** We were very fortunate that our instrument, SLED, provided interesting complementary data on both spacecraft during the early part of the cruise phase of the mission. Then, from the time when Phobos II executed the first elliptical orbit of Mars on January 29, 1989, until contact with the spacecraft was lost on March 27, SLED II provided a treasure trove of measurements. There were also many important observations made during that time by other instruments on board Phobos II, and a special issue of *Nature* covered these results.

**EIR:** In 1998, a wonderful book that you wrote, *Whatever Shines Should Be Observed*, was published in Dublin. Was that the first book that you wrote? How did you come to write about Irish women in science?

**McKenna-Lawlor:** I have written technical books, and chapters in books, and many scientific publications in professional journals, but this is the only book of mine with an historical theme.

The reason I wrote it was because a few years ago, I was a member of a group called Women in Science and Technology. The President of Ireland was then Mary Robinson, and she was patron [of that group]. One day when she came along to one of our functions, she said to me, "I know what you're doing, but did the Irish women in previous centuries have any role in science and technology?" I said that I didn't think so, because they would not have been allowed to go to the university, and they would have had very limited access to scientific literature. She said, "Look. Look for me." And of course, when your President says, "Look for me," that becomes a task one should perform.

I think she must have known something about the heritage involved, because when I came to look, I found that Irish women of the 19th Century had done the most wonderful things. So that was why I wrote that particular book.

**EIR:** So you were not familiar with the material at all before you started it?

**McKenna-Lawlor:** No, I was not familiar with it. However, I was determined that the text would not just be compiled through reading existing biographies of these people, and then gluing it all together. I thought that I should really research the lives of these women. However, this was a bit of a "back-burner" project, in the sense that I had other, ongoing responsibilities that were very pressing, so this was happening in the corners of time I could allocate to it. I did go over to the Royal Society in London, where I found a wonderful collection of letters from one of the women concerned.

In another case, I was very fortunate when I opened a book by another of the ladies, published in 1859. The book had a rather unattractive title—something like, introduction to telescopes, or telescope teaching, or something like. But when I opened it, I found that it contained absolutely beautiful observations that she had made of a comet, which were quite lost inside this book. I was able to take them out, and bring them into the light, shall we say.

I would like to have spent much longer in researching the lives of these women, but at least I tried to add to what was already known about them. I liked them very much. Each lady was a very wonderful person, and I felt that if I had been privileged to know them, we could have been friends.