WORDS OF MANEL SANROMÀ

Rector, authorities, academic colleagues, Dr. Margaret Geller, ladies and gentlemen

It is a great honour for me, as an astronomer and a member of this Senate, to act today as Dr. Margaret Geller's sponsor, on the day of her investiture as an honorary doctor of the Rovira i Virgili University. I would like to thank the rector, in particular, and the Department of Computer Engineering and Mathematics who made the proposal and chose me to carry it into effect.

Margaret Geller is undoubtedly one of the astronomers who has most contributed to changing our concept of the universe in recent decades. This year our University has taken part in the world celebration of the International Year of Astronomy to commemorate the first telescopic observations made by Galileo 400 years ago. The great Italian astronomer, the father of modern science, helped to demonstrate that Copernicus' heliocentric model was the correct description of the known world at the time, which was limited to the sun and the planets, with the stars as fixed points of light in the firmament. The geocentric vision that had dominated human thought up to that time was thus displaced. From that point on there has been a never-ending succession of discoveries that have gradually changed our vision of the Universe and the place occupied by humankind within it. During the 18th century, as the result of speculations by the English astronomer Thomas Wright and the German philosopher Immanuel Kant but in particular because of the observations by the British astronomer (born in Germany) William Herschell, it became clear that the Sun was little more than one of the many stars that made up an immense star system known as the Galaxy: the Milky Way that dominates our skies is simply this system seen from within. The Sun, apparently was at the centre of the Galaxy, a position it occupied until 1920 when the North-American astronomer Harlow Shapley showed that this was not the case. It should be pointed out that, meanwhile, during the 19th century, another revolutionary scientist repositioned humankind in the great theatre of Nature: Charles Darwin, who was born 200 years ago and who published his masterpiece *The Origin of the Species* 150 years ago, demonstrated that humans were not the centre of creation but the product

of an evolutionary process. The changes in our vision of the world, however, were to accelerate during the 20th century.

First it was Albert Einstein who, in 1917, applied his Theory of Relativity to describe the Universe as a whole. Shortly afterwards, the North-American astronomer Edwin Hubble demonstrated not only that our Galaxy is one of many in the Universe but also that they are all moving away from one another, which meant that the Universe is in constant expansion. The Universe is expanding: this was another, apparently definitive, nail in the coffin of anthropocentrism. We were living in an immense Universe, populated by galaxies, and the place occupied by humankind in cosmic evolution was far from special. What is more, for the first time we had a description not only of what this Universe was like but of its origin and evolution. The Big Bang Theory, the work of the Belgian George Lemaïtre and the North American of Ukrainian origin George Gamow, was spectacularly confirmed in 1965 with the discovery of cosmic microwave background radiation by the North Americans Arno Penzias and Robert Wilson, for which they were awarded the Nobel Prize for Physics in 1978.

But there were even more surprises in store. After Hubble's discovery that many nebulae—that up to that time had been regarded as objects in our Galaxy—were in fact galaxies themselves, it started to become clear that these galaxies tended to group together in clumps or clusters, some of which had several thousand members. The explanation for this phenomenon was gravity and there was nothing special in this. On a large scale, however, the Universe was believed to be homogeneous: that is to say, galaxies were uniformly distributed and there were no great agglomerations beyond clumps and clusters. Margaret Geller and John Huchra destroyed this vision. During the 1980s they studied the distribution of thousands of galaxies in three dimensions and used the red shift in the galaxy's spectrum as an indicator of distance, which was added as a third dimension to the two that can be observed in the firmament. Their results were a complete surprise: galaxies are not distributed uniformly but in enormous filaments and walls that limit immense regions in space in which there are practically no other galaxies. The largest of these structures, which they called The Great Wall, was 500 million light-years long, 300 million light-years wide and 15 million light-years thick: these structures were simply too big to have been created by gravity since the beginning of the Universe. This seemed to confirm a suspicion that had been circulating among

astronomers for some considerable time: the Universe did not consist only of known material and energy. It must also have a component known as dark matter (since it only interacts gravitationally and not electromagnetically), which dominates the Universe in relative terms and is necessary to explain the appearance of these large structures discovered by Geller and Huchra.

Now that we have positioned Dr. Geller in the historical transformation of our knowledge of the Universe, we should say a few words about her professional career. Margaret Geller, born in 1947 in Ithaca, New York, graduated in Physics from the University of Berkeley in 1970 and five years later she gained a doctorate in Astrophysics at the University of Princeton, being only the second woman to do so at this elite university. It was at this time that she began to take an interest in the clustering of galaxies, a topic on which she continued to work when she joined the Senate of the University of Harvard. There, in 1973, the Harvard-Smithsonian Center for Astrophysics (popularly known as CfA) had been founded. It was an association of the Observatory of the University and the Observatory of the Smithsonian Institution: to sum up, it was the largest astronomy centre in the world. In this centre, a few years later, the first steps to construct a three-dimensional map of the Universe were taken. The galaxies that we observe with our telescopes are projected onto the firmament and to acquire information about their distance we use what is known as Hubble's Law, which states that the velocity at which galaxies recede from the earth is directly proportional to their distance from us; therefore, if we can measure their velocity we can find out how far they are away. This we can do by using the red shift in the lines of the spectrum of light that reaches us from the galaxies; the well-known Doppler effect, so familiar to us in the sound of a motorbike or an ambulance approaching or receding, can be applied in this instance to light to work out its velocity (and therefore, thanks to Hubble, the distance) of galaxies that are hundreds or thousands of light years away from us. Today, such programmes as the Sloan Digital Survey, have measured the redshift of more than a million galaxies, but the CfA Redshift Survey, which measured 15,000 galaxies, has gone down in history not only for being the first but also for Margaret Geller and John Huchra's great discovery: the Great Wall. This finding confirmed the suspicion of the existence of dark matter which, strangely enough, had first been postulated by Vera Rubin, another great North-American astronomer who

could not do her doctoral studies at Princeton in the 1950s because women were banned.

The fact is that being a woman and a scientist has never been easy. And in the history of Astronomy there are several important examples because women have made a considerable contribution to this ancient science. The first was Hypatia, the director of the Ancient Library of Alexandria who was burnt to death, just as the Library itself was, and there was a whole host of others who, though not murdered, had their work scorned simply because they were women. Among them were Caroline Herschel, who is rarely remembered nowadays unlike her brother William with whom she regularly worked; Maria Mitchell, the first female astronomer to be admitted to the American Association for the Advancement of Sciences but whose salary, even so, was one-third that of her masculine colleagues; the so-called “calculators of Harvard”, a group of women including Williamina Fleming, Antonia Maury and Annie Cannon who carried out an enormous task of photometric and spectral classification of all known stars thanks to which the bases of modern astrophysics were established; Henrietta Lewitt, the first female astronomer to be nominated for a Nobel Prize, who discovered the relation between a Cepheid variable’s luminosity and pulsation period, extremely important for the discoveries of Shapley and Hubble and which is still one of the observational fundamentals of modern Cosmology; and Jocelyn Bell, co-discoverer alongside Antony Hewish of pulsars, which earned him, but not her, the first Nobel Prize ever awarded to an astronomer.

Margaret Geller is well aware of what we are talking about. Her career at Harvard started in 1974, she has worked there ever since (except for a short period during which she was a visiting lecturer at the University of Cambridge in England), and she was even appointed as full professor. She has been given extensive public recognition for her scientific results and her career. She was the first woman from Harvard to be admitted to the National Academy of Sciences and she has received numerous awards and honours from a variety of universities, among which are the McArthur Foundation Fellowship, the Newcomb-Cleveland Award of the American Association for the Advancement of Science and the Magellanic Premium of the American Philosophical Society. All these achievements, however, did not mean that she did not also have to cope with the discrimination that so many women, and particularly scientists, have had

to put up with. In 1997 she was given the good news that Harvard had awarded her the Mallinckrodt chair, an honour traditionally reserved for the university's tenured scholars; in this case, though, the chair did not come with tenure. The university administrators argued that it was a bureaucratic problem not sexual discrimination, but many believe that Geller had fallen foul of the same prejudices that had harmed Annie Cannon and Henrietta Lewitt at Harvard and Jocelyn Bell and Vera Rubin at other universities. To her credit, we should point out that, like Maria Mitchell, the first female American astronomer, she stood up for what she believed in and in 2001 resigned from her post at Harvard to spend her time exclusively at the Smithsonian Observatory.

And it is by no means a small task! As well as publishing more than 200 articles in scientific journals, she has spent a considerable amount of time on information and education by taking part in the production of several scientific films and documentaries. In recent years she played a role in another discovery that was as unexpected as it was significant: the existence of so-called hypervelocity stars, whose velocity is so great that they are able to escape the gravitational pull of the galaxy. They can provide much information about the distribution of dark matter in the galaxies.

We are, then, talking of a first-rate woman, a first-rate astronomer, a scientist who honours science as a professional and as a person. Dear Margaret, our University and our Department are most honoured to have you with us today to accept this honorary degree that you richly deserve. We are proud to be the first Catalan and Spanish University to award an honorary degree to a female astronomer. In this International Year of Astronomy, when we celebrate the great achievements of Galileo we also want to celebrate your contributions to our knowledge of the Universe and your vision of it as a scientist and a woman. Let me use your own words that you said in an interview published in the book *The lives and worlds of modern cosmologists* to summarize your vision of life: "I guess my view of life is that you live your life and it's short. The thing is to have as rich an experience as you possibly can. That's what I'm trying to do. I'm trying to do something creative. I try to educate people. I enjoy encouraging people and meeting people. I enjoy seeing the world and I have as many broad experiences as I can. I feel privileged to be able to be creative."

Rector, insofar as it has been possible, I have described the life and the work of Dr. Margaret Geller. I believe that what I have said is sufficient, with your authority, for her merits to be awarded due recognition. I therefore request that she be awarded an honorary degree and that she become a member of our University.