to say, about 100 million, or so, per cubic metre. With this kind of density a very small mass of neutrinos, corresponding to a rest-mass energy of a few tens of an electron volt, is already sufficient to provide the "closure" density of the Universe. However, there appear to be difficulties with this kind of picture. Calculations which simulate the non-linear growth of structures in the expanding Universe can be compared with the observed distribution of galaxies which, as discussed in detail by J. H. Oort, appear to cluster on the large scale in configurations (superclusters) whose sizes are typically 150 million light-years. In a universe dominated by massive neutrinos, the characteristic scale on which matter condensations can form and collapse is clearly controlled by the maximum distance neutrinos can travel before they are cooled down, due to the expansion of the universe. As pointed out by J. Silk (Berkeley), this distance is too large and apparently leads to a typical size which by far exceeds the observed clustering scale of galaxies. Consequently, if the standard cosmological parameters hold, one would have to conclude that neutrinos cannot provide the missing mass in the Universe. Clearly, the solution to all these problems depends, in the end, on a direct measurement of the neutrino mass. According to R. L. Mössbauer (Munich), who reviewed the experimental situation for the measurements of the masses of the various kinds of neutrinos, the most recent result of an experiment carried out in the Soviet Union indicates that the rest-mass energy of the electron neutrino should be at least 20 eV. This result is clearly of crucial importance and one hopes that other experiments will soon allow to verify its validity.

An important development in theoretical cosmology, which would in fact provide a solution to the isotropy and flatness problems discussed earlier, has recently been proposed by Guth in the framework of GUTs. After the first 10^{-35} seconds, the cooling due to the expansion of the Universe would bring the thermal energy below the grand unification energy of 10^{14} GeV, the electro-weak and the strong forces would again acquire their identity and one would expect something to happen at the transition time (more technically one expects a decrease in the symmetry properties of the fields). Guth's basic idea is that essentially nothing happens for a while: the Universe expands and cools down by many factors of ten, while certain properties of the system remain, so to say, "frozen". The system lives for a while in an "excited" state which would drive the expansion in such a way as to enable an effective exchange of information through the Universe. Essentially, a very small piece of the Universe, which is causally connected in the initial phase of this expansion where, roughly speaking, the expansion velocity is less than the velocity of light, is then stretched by a very large factor (of the order of 10^{44}), and from this piece our entire Universe is made. At the same time, this would lead to a model universe in which the density is *almost exactly* the closure density. When the system makes the transition to its "normal" state, the energy which had been "frozen" in the fields is suddenly released and the Universe is reheated to a thermal energy of approximately 10^{14} GeV, and the considerations we outlined before apply again. It is as if the Universe was born anew. These types of theoretical schemes are known as inflationary models. As discussed by D. Nanopoulos (CERN), however, there are still a number of difficulties concerned with a fuller understanding of the basic physics at work and, in particular, the most recent investigations lead to models that are affected by inhomogeneities which appear to be so large that their presence would contradict what can be allowed in the real Universe. However, the basic idea of "inflation" is extremely appealing and one other possibility is that it can be applied to even earlier times, when the Universe was only 10^{-43} seconds old. This time, known as the Planck time, corresponds to a thermal energy of approximately 10^{19} GeV above which all four fundamental forces of nature are unified, including gravity. The basic physics prevailing at that moment may be correctly described by the so-called supersymmetric theories, such as "supergravity". The most remarkable property of these theories, as reviewed by Fayet, is that they correlate particles with adjacent spins, such as particles with spin 1 and spin ½, and therefore bring together bosons (such as the photon) and fermions (such as the electron and the proton). The existence of a number of new particles is then predicted. Thus, in "supergravity", which originates from supersymmetry by assuming that its properties are locally invariant, one recovers not only the graviton, which is the spin 2 particle which mediates the gravitational field in general relativity, but also a spin 3/2 particle called the gravitino. Thus, the partner of the photon would be a new spin 1/2 particle called photino. These new particles, the ". . . ino"s, could play an important role in cosmology and, if massive, they could provide the missing mass needed to close the Universe, avoiding some of the problems associated with neutrinos as previously illustrated.

Clearly, supersymmetric theories are still highly speculative and there is, as yet, no experimental verification of their validity. However, it is interesting to note that astronomical observations could shed some light on the existence of the new particles that are predicted. For instance, Sciama has pointed out that the annihilation of photinos and anti-photinos, if they are indeed massive enough, could produce a large background flux of radiation detectable by far ultraviolet and soft X-ray measurements.

Thus the Universe appears to provide the "natural" laboratory where one can hope to test fundamental theories of physics, while, at the same time, any progress in experimental particle physics may increase our confidence that these theories can be applied to an understanding of the basic

SECOND ANNOUNCEMENT
OF AN ESO WORKSHOP ON

THE VIRGO CLUSTER OF GALAXIES

Since the first announcement of this workshop was issued in the previous Messenger (No. 34, December 1983) the date has been fixed and a preliminary programme made. The workshop will be held in **Garching,** from **September 4–7, 1984.**

The programme covers the following topics: Redshifts, observations in the radio continuum and in H I, infrared observations (with special emphasis on IRAS results), optical spectroscopy, spiral pattern analysis, galactic content and structure, the population of dwarf galaxies, UV and X-ray observation, the cluster dynamics, and the interaction with the environment.

Among the invited speakers are: W. Forman, W.K. Huchtmeier, J. Huchra, R.C. Kennicutt, C. Kotanyi, A. Sandage, G.A. Tammann and R.B. Tully.

Those interested in participating in this workshop and/or presenting contributed papers (probably mostly in the form of poster papers) should write to:

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