PREFACE

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The Netherlands Foundation for Research in Astronomy (NFRA) came into existence on 29 April, 1949. Its mission was to build on the technological advances of the Second World War that would allow detection and study of radio waves from the Cosmos. Surplus radar antenna's were to be pressed into service and a new large antenna was to be designed, with the twin goals of searching for the predicted line of hydrogen at 21cm wavelength and of mapping the continuum radio noise from the sky that had been discovered just prior to the War. These tasks were judged too great for the university community at the time and were to be accomplished by the new, nationally financed foundation.

From this beginning our organization has grown together with the field of radio astronomy, and we like to think we have played an important role in shaping that science. During the 1950's we showed that neutral hydrogen gas is a primary component of the Milky Way galaxy, and in the 1960's we mapped its motions and its detailed distribution. During the 1970's and 1980's we went extragalactic, mapping hydrogen gas in systems other than our own and helping to bring the non-thermal, high energy Universe into focus. We showed convincingly the necessity for substantial amounts of dark matter in the haloes of galaxies and we helped reveal how jets of plasma connect the central engines of powerful radio galaxies with their extensive outer structures.

This record of discovery has required a strong facilities program and a forward looking technical development effort. Over the years the Dutch government has provided substantial support to both ends. For a decade from 1970 our Westerbork Synthesis Radio Telescope (WSRT) was the world's largest instrument of its kind, and set the agenda for much of radio astronomy. During the 1980's, to provide our astronomical community with complementary capabilities in other wavelength regions, we broadened our program to include optical and sub-mm facilities and instrumentation. But an inescapable fact of climate here in northern Europe keeps radio astronomy a major thrust of our program.

Most recently we have completed upgrading our primary instrument, the WSRT, in effect making it a new telescope. Now for the first time we are able to move beyond the local Universe, to study atomic hydrogen and various sorts of molecular gas in galaxies as a function of redshift and hence of cosmic time. We can also now observe simultaneously at widely separated frequencies to probe the physics of transient phenomena. And together with our partner institutes of the European VLBI Network we are now deriving parallaxes and proper motions of radio emitting objects in the Galaxy with extraordinary precision.

These new capabilities have led us to start thinking about the future and the role radio observations can and should play in the development of astronomy in general. What will it take to investigate the first objects formed in the Universe? Can we detect and map the re-ionization epoch just prior to galaxy formation? Can we reveal the evolution of the dark matter components of galaxies? Of the formation and evolution of the massive black holes at the centers of galaxies? Of the origins and evolution of cosmic magnetic fields, both in intergalactic space and in star forming regions? These and many other basic questions are on our agenda just as they are in other communities and in other branches of astronomy. We have learned how hard it is to think about and plan for the future a decade or more hence, when the scientific landscape is likely to be unrecognizable from today's perspective.

Several things have become clear, however. It really should be possible to detect and study the earliest cosmic epochs even before the heavy chemical elements were present, as the global cosmic medium re-ionized and the first stars and galaxies formed. And the whole subsequent history of the Universe will then in principal be open for study. The sensitivities of current facilities are inadequate for these investigations, of course, but only by a factor of a hundred or so. While daunting, such a factor can be

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bridged by technology if one invests appropriately.

Most of our readers will be aware that several years ago our community asked NFRA to address this challenge, to begin a research and development program that, together with efforts elsewhere in the world, will ultimately enable the design and construction of a radio telescope having a collecting area a hundred times that of existing facilities. The project is going by the name, the Square Kilometer Array (SKA), and it is gathering momentum world-wide as more and more astronomers realize that it is the logical next step in the field.

As our technical studies have progressed it has become clear that current approaches to building radio telescope – movable mechanical dishes to concentrate the flux before detection – will unlikely offer a viable way forward. The cost of steel is not decreasing with time, so the cost of scaled up versions of current designs will remain prohibitive. But the cost of electronics to perform any given function continues to decrease dramatically with each passing year. Clearly, the radio telescopes of the future should minimize their signal processing by mechanical structures and maximize their use of electronics. SKA will in all likelihood, at least over the frequency range important for observing the history of atomic hydrogen gas in the Universe, be an electronically pointed array antenna that looks a lot like a field full of solar panels.

To turn this vision into reality will require a concerted program of activities. The full range of the science likely to be important must be identified, including areas that are currently only dimly perceived. The technological challenge needs to be better defined, including how to deal with technological evolution on timescales much shorter than any realistic estimate of the duration of the project. And while radio astronomy had it origins in electrical engineering two generations ago, astronomers today increasingly have a multi-spectral approach to their science, with the consequence that the necessary technological innovation is occurring predominantly outside of astronomical institutions. Astronomers and technologists need to come together to begin the dialogue that will ultimately make the SKA a reality.

As we approached our Golden Jubilee anniversary, we therefore decided to celebrate by inviting friends and colleagues from around the world to consider with us the future of radio astronomy at centimeter and meter wavelengths. We chose to do this by organizing two, back-to-back symposia, the first focussing on the astronomy and the second on what currently seem to be the most relevant technologies.

We chose to begin in Amsterdam, on April 7-9, because that city can be extraordinarily lovely in the springtime, and to continue in Dwingeloo, on April 12-13, because we wanted to show off the results to date of our R&D activities. To maximize the opportunities for cross fertilization we tried to limit the attendance at each conference to no more than 70. In the event, however, interest was widespread and we ended up hosting 108 scientists in Amsterdam and 119 in Dwingeloo, coming from in total ten countries and with a gratifying degree of common attendance.

These two volumes record the results. In the broad range of contributions the first demonstrates the wide spectrum of fascinating science that can be addressed at these frequencies. In the months since the conference, astronomers in the Netherlands and elsewhere have already begun observations to address some of the new ideas that were presented in Amsterdam.

The second volume provides the views of experts on the state of technology as well as some hints as to the directions it is likely to develop. A recurrent conclusion is that the relevant technologies are also of great importance to the commercial and military worlds. Evidently, we in radio astronomy will be able to ride a wave of planned development that is supported by dramatically greater resources than will be available to ourselves directly. If we are clever, we should also be able to contribute to a limited extent to those developments and thereby maximize the synergy.

Finally, let me formally record our thanks to the organizations that have contributed to making these symposia a success. Our sponsors were the Nederlands Elektronica en Radio Genootschap, the Benelux chapter of the IEEE, the British Institute of Electrical Engineers, our research council NWO, the Executive Council of the Province of Drenthe, the Leids Kerkhoven-Bosscha Fonds and the Royal Netherlands Academy of Arts and Sciences.