ADDRESS BY THE PRESIDENT OF THE INTERNATIONAL ASTRONOMICAL UNION, PROFESSOR J. H. OORT

Mr Chairman, Ambassador Stevenson, Doctor Menzel, Regent McLaughlin, Representatives of our sister Scientific Unions, Ladies and Gentlemen:

It is a pleasure to open the second General Assembly which the International Astronomical Union is holding in America. It is a special privilege to be able to do this in California, to which astronomy owes so much of its development in this century. We are deeply indebted to the Government of the United States and the National Academy of Sciences for inviting us to their country and in particular for providing the means to enable us to hold so complete a meeting at such a large distance from Europe. I thank President Kennedy and the Governor of California for their messages of welcome. That you, Ambassador Stevenson, have come to Berkeley especially for this occasion to welcome us, is a source of particular gratitude. You may be assured that we astronomers will do all we can to make our small contribution to international understanding as perfect as possible. World-wide international co-operation in astronomy dates back much further than such co-operation on political or economic levels. And I think that *we* have already arrived at the point where competition between nations has become almost entirely replaced by the strong conviction that it is only by helping each other internationally that we can really succeed in penetrating into the Universe.

An important part of the history of the American people is connected with the migration to the west. It even seems that, after having reached the western boundary of their continent they could not resign themselves to halt there, and, becoming possessed by a desire to penetrate further and further, they reached out into the skies. Thus they became pioneers of large telescopes, through which their thoughts travelled out into space. Here there was no boundary to stop them and they boldly headed for the outer limits of the physical universe.

It was near this West Coast that the first large mountain observatory was founded on Mount Hamilton. Under the auspices of the University, which has received us with such great hospitality, a large 36-inch refractor was there installed in 1888. Already early in its history the Lick Observatory has made basic contributions to our knowledge of the motions of the stars. It is continuing this today with an invaluable survey in which stellar positions are tied to the motionless background of distant galaxies. With a new 120-inch telescope it is now entering a new phase of its existence. I may use this opportunity to extend to the Lick Observatory and to the University of California the good wishes of all astronomers who are here today, and to express the impatience with which we wait for the treasures which the Lick astronomers will gather out of the depths of the Universe.

At one time there was a personal union and triple alliance between the Lick Observatory, the University of California and the Astronomical Union, when W. W. Campbell, who had been director of the Lick Observatory and later president of the University of California, became president of our Union. We are happy that this alliance of the past is now reborn in an actual coming together.

The greatest development of astronomy in the United States has been inspired and led by a man who appeared to have combined almost all of the best human qualities. It is fitting that on this first large international gathering in California tribute be paid to George Ellery Hale, without whose penetrating foresight, idealism and perseverance neither the Mount Wilson Observatory nor the giant telescope on Mount Palomar would have come into existence.

It was with the 60-inch telescope on Mount Wilson that Harlow Shapley obtained the first insight into the actual size of the Galactic System and the Sun's eccentric position in this

System. It was also with the 60-inch that he found the characteristic colour-magnitude diagrams of globular clusters which theoreticians together with astronomers on Palomar later developed into such a wonderfully penetrating picture of stellar evolution. Hale's second large instrument, the 100-inch telescope on Mount Wilson, was, at its completion in 1917, as much ahead of its time as the 60-inch had been in 1909. With this instrument Edwin Hubble and, later, Walter Baade, revealed the true character of the 'great nebulae', indicating that they were enormous star systems, like our own Galaxy. In the same period Hubble began his great attack on the universe, an attack that was to be completed with the new telescope on Palomar. This new telescope, which was named after Hale, was such a grand conception that, though it is now thirty-three years since the plans for it were started, the instrument still completely commands the field. It is in the 200-inch telescope that the courage and skill of the American people are shown at their best. It is perhaps the most exquisite blossom that has ever grown from the meeting of science and technique.

Practically all we know about stellar systems outside the Galactic System and the Clouds of Magellan, has been discovered with the giant telescopes in the Western United States. It may therefore be fitting at this occasion to dwell for a moment on some of the problems in this domain by which astronomers are now confronted.

If you look through the Hubble Atlas of Galaxies, which has just been completed by Sandage, and which you will certainly find on display, you will be particularly struck by two things: In the first place by the great variety of forms, in the second place by the fact that the majority of galaxies have structures that cannot possibly be in equilibrium. These galaxies seem to be midway between a curious kind of chaos and a stage in which they would become well-mixed and regular. They clearly bear the imprint of their birth in a past and quite different phase of the universe. One of the most fascinating problems is to penetrate into that distant past and to find out what it was that gave the galaxies the curious spiral and other shapes that we observe today. The investigation is as difficult theoretically as observationally. It requires among other things a much more advanced knowledge of the role of magnetic fields in galaxies and of plasma physics than we possess today. So far, we have hardly been able to decipher any of the hieroglyphs of these galaxies. And more riddles appear to come up all the time. We can only optimistically hope that when we have amassed enough enigmas the solution may be near. There are two other roads beside that of the structure and dynamics of galaxies that appear to lead to that most distant past. One goes through the star clusters and their ages. The oldest clusters appear to be between twenty and thirty billion years old and probably date from the time when the Galactic System was born. The third road is that of the expanding universe, which indicates that the entire Universe was born at about the same time as these oldest star clusters. Or, at least, that it evolved at that time from something different from the present universe. On this point, however, there is still some divergence of opinion. All of the three fascinating fields that I have mentioned are in a rapid state of development. The large reflectors on the American continent, headed by the 200-inch, play a leading part in the observational and most important side of this development.

Since the war a totally different kind of observing has come to our aid, namely, observations at radio frequencies. There can be no doubt that radio telescopes, when sufficiently large, permit observations penetrating much deeper into the Universe than is possible by optical means. It is clear from the outset that this possibility contains a promise for extremely interesting discoveries. Radio instruments have already helped the 200-inch to find a galaxy running away from us with half the velocity of light, and having an age of about half that of the universe directly around us. It is most likely that a search out to much larger distances, such as appears possible with the largest radio telescopes, will reveal quite novel things. In fact, there are indications that they are already doing so. These observations will be a topic of

discussion at this meeting. The radio galaxies which form these most distant signposts in the Universe are themselves most enigmatic objects. We have not yet the slightest idea what causes some galaxies, or pairs of galaxies, to become such powerful radio emitters.

Here, as in many other domains of astronomy, it is a symbiosis between different observing techniques which is making the big advance possible. It would be interesting to speculate how far radio astronomers could have developed the subject of radio sources if they had not had the help of large optical telescopes. I think that it would long have remained a hopelessly speculative field. In a sense one might say that, but for the help of large optical instruments, radio telescopes are almost blind.

The advent of the radio telescope has brought a large change in astronomy. Not only by extending its scope, but also in changing the character of our science. Our ranks have partly been filled by electronic engineers and physicists. Moreover, astronomy, which used to share with music, mathematics and painting the privilege of being something for which there was little direct practical application, and which because of that was left quietly to pursue its own ideals, has now become something of the world: the technical world, which is interested in the low-noise amplifiers as well as in other problems connected with the electronics part of radio astronomy. In addition, an entirely new situation has arisen, where astronomy has come into conflict with society. Communication services, television and broadcast transmitters are rapidly filling the ether with so much noise that it becomes impossible for the radio astronomer to hear the extremely weak signals coming from the outer limits of the Universe. This is a matter of life or death for radio astronomy as well as for scientific space research. Other grave dangers for astronomy have arisen by plans to put reflecting screens consisting of small dipoles in orbits around the Earth. The International Astronomical Union has an important duty in backing by its full authority the Inter-Union Committee which it has entrusted with the task of obtaining free channels for radio astronomy and space research, and of protecting the interests of astronomy from human inroads in the sky.

A still greater change in the character of our science has come through the development of that younger brother of radio astronomy: space research. In opening the congress of the Union in 1958 Professor Danjon expressed his admiration for what had then been accomplished in the successful launching of sputniks and other space vehicles, in connection with the International Geophysical Year. Since then, there has been a still more rapid development than could have been foreseen. I may remind you only of that wonderful first experiment made by our colleagues of the Soviet Union in which they obtained pictures of the rear side of the Moon and also of the interesting investigations on cosmic-ray particles outside the atmosphere which led to the discovery of the Van Allen belts, about which we shall hear a first-hand report during this meeting.

Particularly important for astronomy are the projects for putting telescopes of considerable size in vehicles above the atmosphere. There can be no doubt but that the realization of these plans will offer immense new possibilities for astronomical research. I would not try to predict the nature of the results. For, like in radio astronomy, the most interesting are likely to be the things of which nobody has any inkling. These purely astronomical space projects, as well as the enormous Government plans for manned journeys through the planetary system, are absorbing an increasing number of our small astronomical family, but they are at the same time adding a large fringe of distant relatives in the form of electronic engineers, space physicists and future space travellers.

The astronomical workshop is seething with life. Almost everybody appears to be hammering and building. It is a joy to watch this activity and it is making the old astronomers wish to live long enough to see the results.

But it also poses problems for our Union. Problems for which we shall have to find a solution if we wish to keep it successful. I have been in close contact with the Union throughout its life. I may, in fact, be the only astronomer who has been to all eleven General Assemblies, although in 1922 I attended only by accident and quite unofficially. At that Rome meeting there were eighty-three members and guests; it was the nicest General Assembly I have seen! Since then every meeting became larger than its predecessor, and after the war they began gradually to grow out of hand. At the same time also the administration of the Union became too much for a single general secretary, even for such exceptionally efficient secretaries as we have recently had.

Though the General Assemblies of the Union continue to fulfil a most useful purpose in bringing together representatives from all different branches of astronomy, thus helping to develop these branches in such a way that they are most useful for one another, and though they continue to be a fruitful meeting place for old and young astronomers from all nations and vocations, we must nevertheless ask seriously whether or not we should go further in this way. I must confess that I feel quite uneasy about this. We must not run the risk that by an unwieldy size of our meetings the possibility of forming close ties and friendships is lost, or that some of our best astronomers refrain from attending because of disappointment about the too large meetings. The Union should, in time, take steps to ensure that its fine tradition of international co-operation is preserved. But what should be the steps? Is the only way out to arrange for separate Assemblies for different subjects, for instance, the Planetary System, the Sun, Stars and Galaxies?

For the present we still have all subjects of astronomy united. And we must enjoy this meeting to the fullest extent.

That this gathering of astronomers will be a successful and happy one can hardly be doubted since we are meeting in California. For this state of California was named after a fabulous island described in the sixteenth century by Ordonez de Montalvo as being situated *close to Paradise*; for astronomers it *is* the paradise!

May some of this paradisian spirit pervade our meetings and also the new international ties that will be knotted during these days.

The President then repeated part of his address in the French language, as follows:

C'est un plaisir pour moi d'ouvrir la seconde Assemblée Générale que l'Union Astronomique Internationale tient en Amérique. Mais c'est pour moi un privilège tout à fait spécial d'ouvrir cette assemblée en Californie, pays qui a contribué d'une façon si éminente au développement de l'astronomie dans ce siècle.

Nous sommes infiniment reconnaissants au gouvernement des Etats-Unis et à l'Académie Nationale des Sciences de nous avoir invité dans leur pays. Nous avons été particulièrement sensibles aux facilités qu'ils nous ont accordées pour nous permettre d'organiser une assemblée générale si nombreuse dans un pays aussi éloigné de l'Europe. En particulier je souhaite la bienvenue à l'Ambassadeur Stevenson qui est venu de si loin pour ouvrir notre Assemblée.

Une grande partie de l'histoire du peuple Américain est intimement liée à la migration vers l'Ouest. Il semble même qu'ayant atteint les limites extrêmes de leur continent ces hommes n'ont pu se résoudre à s'arrêter là, et toujours possédés par le désir d'aller de plus en plus loin, ils s'échappèrent dans les cieux. Ainsi ils devinrent les pionniers de ces grands télescopes qui permirent à leurs pensées de voyager dans l'espace. Là il n'y avait plus de limites pour les arrêter et ils partirent hardiment vers la découverte des frontières de l'univers physique. C'est sur cette côte ouest que fut fondé au Mont Hamilton le premier grand

observatoire de montagne. Sous les auspices de l'université même qui nous reçoit aujourd'hui si généreusement, un grand réfracteur de 90 cm y fut installé en 1888.

Le grandiose développement de l'astronomie aux Etats-Unis a été inspiré et dirigé par un homme qui réunissait en lui toutes les plus grandes qualités humaines. Il est opportun de rappeler, à l'occasion de cette première grande réunion internationale de Californie, avec respect et reconnaissance le nom de George Ellery Hale. Sans son intuition, son idéalisme et sans sa persévérance ni l'observatoire du Mont Wilson ni le télescope géant du Mont Palomar n'auraient vu le jour.

C'est avec le télescope de 60 pouces du Mont Wilson que Harlow Shapley a pu se faire une idée des dimensions actuelles du système galactique et de la position excentrique du soleil dans ce système. C'est encore grâce à ce même télescope de 60 pouces qu'il a pu construire pour les amas globulaires les diagrammes couleur-luminosité si particuliers et dont l'interprétation récente par les théoriciens et les observateurs du Mont Wilson a fourni une image si merveilleusement nette de l'évolution des étoiles.

Le second grand instrument de Hale, le télescope de 2,50 m, lui aussi installé au Mont Wilson, était au moment de son achèvement en 1917 aussi perfectionné pour son époque que l'était en 1909 le télescope de 1,50 m. C'est avec ce nouvel instrument que Edwin Hubble et plus tard Walter Baade nous ont révélé la véritable nature des "grandes nébuleuses" en découvrant qu'il s'agissait d'énormes systèmes stellaires ressemblants au système galactique. C'est à la même époque que Hubble a commencé à s'attaquer sérieusement à l'univers lui-même; cette attaque a d'ailleurs été développée et continuée avec le télescope du Mont Palomar. Ce nouveau télescope, auquel on a donné le nom de Hale, était d'une conception si grandiose qu'actuellement encore, 33 années après le début du projet, il est toujours l'instrument par excellence dans le domaine des recherches sur les galaxies.

Pratiquement, tout ce que nous savons des systèmes stellaires situés en dehors du système galactique et des Nuages de Magellan a été découvert à l'aide des télescopes géants de l'ouest des Etats-Unis. C'est pourquoi je voudrais m'attarder un peu en examinant avec vous quelques uns des problèmes sur les galaxies que discutent actuellement les astronomes.

En regardant l'atlas des galaxies de Hubble, qui vient d'ailleurs d'être complété par Sandage et dont vous pouvez feuilleter un exemplaire exposé ici même, on est frappé surtout par deux choses: d'abord par la grande variété des formes et ensuite par le fait que la majorité des galaxies ont des formes qui, sans doute, ne peuvent pas être des formes d'équilibre. Ces galaxies semblent se trouver à mi-chemin entre un ancien état de chaos et un état dans lequel leur matière est bien mélangée. Ces galaxies portent nettement l'empreinte de leur formation pendant une phase antérieure et très différente de l'univers. Un des problèmes le plus fascinants qui se posent à nous est de pénétrer dans ce passé lointain et d'essayer de découvrir ce qui a donné aux galaxies leur forme en spirale ou ces autres aspects curieux que nous observons actuellement.

Il y a deux autres voies, en dehors de celle qui passe par la structure et la dynamique des galaxies, pour nous mener à ce passé si lointain. L'une est celle qui nous y mène par les amas stellaires et la détermination de leurs âges. L'autre est celle de l'univers en expansion qui nous apprend que l'univers dans son ensemble a pris naissance à peu près en même temps que les amas stellaires les plus vieux.

Depuis la guerre une technique d'observation tout à fait différente est venue à l'aide de notre science: l'observation dans le domaine des fréquences Hertziennes. Il n'y a pas de doute que les radiotélescopes, pourvu qu'ils soient suffisamment grands, nous permettent d'observer des régions beaucoup plus lointaines que celles que nous pouvons atteindre avec des moyens optiques.

Dès maintenant ces possibilités nous font entrevoir des découvertes du plus haut intérêt.

Ce sont les radiotélescopes qui ont aidé les télescopes du Mont Palomar à découvrir une galaxie qui s'éloigne de nous avec une vitesse égale à la moitié de celle de la lumière. Cette galaxie a un âge égal à la moitié de celui de l'univers dans notre voisinage immédiat.

Il est tout à fait certain que la poursuite de ces recherches vers de plus grandes distances, comme cela est possible avec les plus grands radiotélescopes, révèlera des choses tout à fait nouvelles. En fait, certaines indications nous montrent que nous sommes déjà sur cette voie.

Ici, comme dans beaucoup d'autres domaines de l'astronomie, c'est la symbiose entre différentes techniques d'observation qui permet les grands progrès. L'avènement du radiotélescope a produit un grand changement en astronomie, non seulement en étendant son domaine, mais encore en changeant le caractère de notre science. Des ingénieurs électroniciens et des physiciens ont rejoint nos rangs.

De plus, une situation tout à fait nouvelle s'est présentée: l'astronomie est entrée en conflit avec la société. Les services de télécommunication remplissent si rapidement l'éther avec de si nombreux bruits qu'il devient impossible aux radioastronomes d'entendre les très faibles signaux qui parviennent des limites extrèmes de l'univers. Ceci est devenu une question de vie ou de mort pour la radioastronomie aussi bien que pour les recherches scientifiques de l'espace. D'autres graves dangers guettent l'astronomie par le projet de mettre en orbite autour de la terre un écran réfléchissant constitué par des petits dipôles.

Un changement encore plus grand dans le caractère de notre science est arrivé avec le développement de la jeune soeur de la radioastronomie, la recherche spatiale.

En ouvrant le Congrès de l'Union en 1958, M. Danjon exprimait son admiration pour ce qui avait été accompli dans le lancement réussi des spoutniks et d'autres véhicules spatiaux à l'occasion de l'Année Géophysique Internationale. Depuis lors les événements se sont développés beaucoup plus rapidement qu'on aurait pu le prévoir. Je vous rappellerai seulement cette merveilleuse expérience faite par nos collègues de l'Union Soviétique lorsqu'ils ont obtenus pour la première fois des images de la partie invisible de la lune.

Je vous rappellerai aussi les très intéressantes recherches sur les rayons cosmiques en dehors de l'atmosphère qui ont conduit à la découverte des ceintures de Van Allen. Nous entendrons d'ailleurs au cours de notre Congrès un rapport de première main sur cette question.

Les projets de placer des télescopes de diamètre considérable dans des véhicules spatiaux sont particulièrement importants pour l'astronomie. Sans aucun doute la réalisation de ces projets offre d'immenses possibilités tout à fait nouvelles pour la recherche astronomique.

L'atelier astronomique regorge de vie. Presque tout le monde semble avoir pris le marteau pour construire. C'est une joie d'observer cette activité et les astronomes âgés souhaitent de vivre assez longtemps pour en voir les résultats. Mais cela pose aussi des problèmes à l'Union, problèmes que nous devons résoudre si nous voulons que l'Union continue à travailler avec succès.

A la première assemblée de notre Union qui s'est tenue à Rome en 1922, il n'y avait qu'une assistance de 83 membres et invités. C'est l'Assemblée Générale la plus agréable que j'ai vue.

Depuis, chaque Assemblée devient plus importante que la précédente et depuis la Guerre il devient presque impossible de les diriger. Or, bien que les Assemblées générales de notre Union aient continué à poursuivre un but très important en permettant la rencontre des représentants de toutes les branches de l'Astronomie, et qu'elles aident ainsi ces branches à se développer de façon harmonieuse, et bien qu'elles continuent à être un lieu de rencontre des plus utiles pour les astronomes jeunes et vieux de toutes les nations, nous devons nous

demander sérieusement si nous devons ou non continuer dans cette voie. Je dois avouer que je suis très inquiêt et très indécis à ce sujet.

Nous ne devons pas courir le risque que des assemblées trop nombreuses empêchent les astronomes de nouer des liens d'amitié, ni le risque de voir certains de nos meilleurs astronomes, déçus par ces trop nombreuses assemblées, éviter nos réunions.

L'Union doit, à temps, prendre des mesures pour assurer que cette belle tradition de coopération internationale soit préservée. Mais quelles doivent être ces mesures? Le seul remède serait-il d'organiser des réunions séparées sur différents sujets, par exemple, le système planétaire, le soleil, les étoiles et les galaxies?

Actuellement tous ces domaines de l'Astronomie sont encore réunis et nous devons nous réjouir et en profiter pleinement.

Comme cette réunion a lieu en Californie, nous ne pouvons douter, un seul instant, qu'elle sera une pleine et heureuse réussite. Cet Etat de Californie dont le nom vient de cette île fabuleuse décrite au seizième siècle par Ordonez de Montalvo comme étant située *près du Paradis*, pour les astronomes *c'est* le Paradis.

Puisse cette atmosphère de paradis régner sur nos réunions et aussi sur les nouveaux rapports internationaux qui seront renoués pendant ces journées.

Dr Goldberg thanked Professor Oort for his address and then called upon Ambassador Adlai E. Stevenson to address the assembly.

ADDRESS BY THE REPRESENTATIVE OF THE UNITED STATES OF AMERICA, AMBASSADOR ADLAI E. STEVENSON.

On behalf of the Government of the United States, and of the American people, it is my duty and my privilege to express to all of you, the distinguished members of the International Astronomical Union, a most cordial welcome to this country.

In this gathering are learned scientists from every continent and latitude, from Australia to that ancient cradle of astronomy, Egypt. We heartily welcome you all to the United States. And since Moscow was the site of your most recent Assembly three years ago, it is my particular pleasure to greet the large and distinguished delegation which has come here from the Soviet Union.

For yours is a community of the mind—ordered by reason, united in the single pursuit of truth about the universe. We who try to keep the peace among unruly nations cannot help envying and admiring your unity and purity of purpose. Would that all of us at the United Nations could follow your example, would that all of us could unite to end cold war and conflict, and concentrate on the arts of peace and the wider enjoyment of the benefits of this age of unparalleled technical progress.

I have been told that one of the reasons the astronomers of the world co-operate is the fact that there is no one nation from which the entire sphere of the sky can be seen. Perhaps there is in that fact a parable for national statesmen, whose political horizons are all too often limited by national horizons. In the United Nations we have mankind's greatest attempt so far—halting though it is—to widen all our horizons, to cause all men and all nations to accept the fact that there is but one world, without horizons other than the common horizon of illimitable space—one world not only in science, not only in the search for truth, but in the ordering of their international lives.