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SOME PROGRESS BY CHINA IN THE AREA OF SPACE SCIENCES

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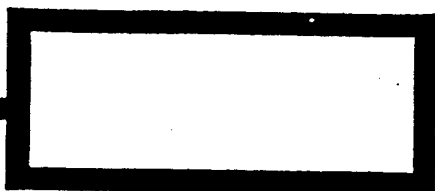
Wang Daheng

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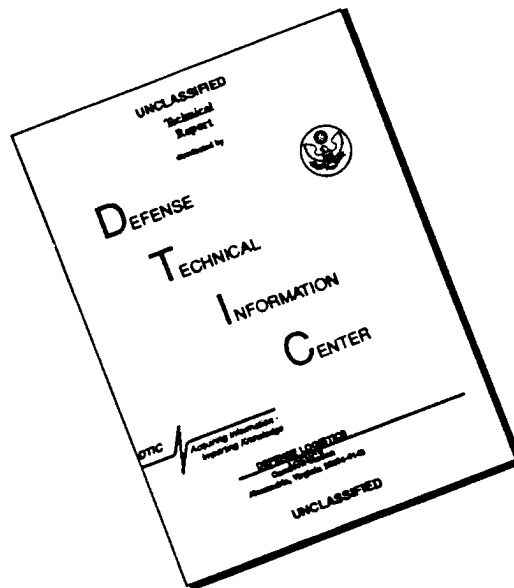


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By: Wang Daheng

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## SOME PROGRESS BY CHINA IN THE AREA OF SPACE SCIENCES

Wang Daheng

What is discussed here is not only the development of space technology itself or scientific and technical questions due to the development of technology which need solving. The emphasis is, however, on making a summary description of the accomplishments which have been achieved by space technology with regard to developments which it has promoted in other scientific fields.

### I. Remote Sensing and Observations of the Earth

What is spoken of here as remote sensing refers primarily to the use of optics or electromagnetic radiation to acquire imagery information from above the earth (including aircraft and satellites) with regard to surface structures (for example, jungle, cultivated land, deserts, as well as arid land, the geomorphology of mountains and rivers, and regimen). It is different from traditional high altitude photography. The detection means it makes use of include photography as well as modern photoelectric sensors. It is not only capable of observing the profiles of surface structures. It is also capable of making use of spectral characteristics associated with surface objects (including electromagnetic radiation) in order to identify the make up of objects. Speaking in terms of forms, precise determinations are carried out with regard to the position and form at each point on the surface of the earth. In conjunction with this, spectral identification analyses are done.

The area of China's national territory is vast. It is criss crossed with mountains and rivers. Getting a clear grasp of the natural state of the surface is a matter of months and years. In the past, in order to carry out pannational surveys associated with the utilization of national territory, it was necessary to use several decades of time. Due to changes in the situation, data which surveys obtained was usually obsolete. With the high tide of construction at the present time, changes are very rapid.

How to obtain global imagery which reflects the current situation in a timely manner is a big problem. China still has large areas which are criss crossed by mountains and rivers and are difficult regions to set foot in. In the past, making use of aerial photography resolved a number of problems. Moreover, at the present time, making use of resource satellites to do space remote sensing, it is then possible to take a broad, far reaching view--very, very greatly improving the timeliness of information photographed on the surface.

As far as Chinese remote sensing at the present time is concerned, information data sources lie in several areas.

1. From Imagery or Video Tape Acquired from Foreign Resource and Land Satellites. These satellites include the U.S. LANDSAT, the French Sibote (phonetic), the European Space Agency's Global Resources Satellite, as well as Japan's Resources Satellite. These satellites periodically photograph geographical information on a global scale. There are some differences in surface resolution--in accordance with different spectral wave bands and satellite types--from 10 meters to 70 meters.

2. From Foreign Satellite Remote Sensing Data Acquired by the Use of a Resources Satellite Surface Receiving Station Set Up Through Foreign Assistance by China in 1986.

3. From Information Acquired in a Timely Manner by Foreign as well as Our Own Metrological Satellites. This is primarily atmospheric and oceanic survey data. Resolutions are generally 1 kilometer. It is also capable of being used in order to distinguish large area surface information--for example, jungle fires, and so on. On the basis of international metrological satellite treaties, this type of information must be shared with the world. To this end, China has set up three surface stations on the ground--in Beijing, Urumqi, and Guangzhou. As a result, data obtained is capable of covering the entire nation and adjoining regions. In the weather forecast programs which are broadcast every day, the satellite metrological cloud maps which we are seeing are obtained in just this way.

Generally, in order to precisely analyze and understand surface situations, the various types of information discussed above must also go through modern imagery information processing.

To this end, there is a need to use integrated equipment associated with complicated optics, electronics, and large capacity electronic computers. Only then is it possible to obtain the particularly fine imagery needed.

The status of China's remote sensing and earth observation operations is roughly as follows.

1. Metrological Operations. Atmospheric information obtained from metrological satellites includes various types of atmospheric and surface elements. Moreover, they are provided in a comparatively timely manner. With international assistance, China set up satellite metrology centers. Besides providing source material for weather forecasts each day, they are also used in order to carry out research work on such things as atmospheric circulation--for example, typhoon formation and East Asian atmospheric kinetics. These things are all related to agricultural crops and precautions against natural calamities. Recently, the Milky Way No.2 large model electronic computer which was developed by China on her own (operational speed of 1 billion iterations/second) was used, for the first time, in the

calculation of weather forecasts. The objective is to extend the time periods during which forecasts are possible and to improve accuracy.

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2. Geographical Map Making. As far as the making of maps is concerned, it is dependent on large amounts of measured coordinate data and survey materials associated with measured benchmarks. After that, symbols and colors act as indicators to make them with. Due to the fact that numbers of operations are huge, the nation has, therefore, set up specialized agencies in order to handle this work. However, this is not a matter which can be finished once and for all. The activities of mankind and changes in the natural environment will all lead to maps needing timely revisions. With regard to developments associated with the economic situation, requirements for completeness and timeliness in maps will also get higher and higher. The use of remote sensing technology in the preparation of maps can then very, very greatly shorten preparation time periods. Making use of this type of technology is also capable of bringing into play the advantages of remote sensing imagery--displaying maps in accordance with natural landscapes--and is not completely converted to symbols. In recent years, China has achieved success in preparing pannaional, full size satellite photographic maps. To this end, since 1970, approximately 2000 frames of space imagery materials have been collected--acquired from different satellites--covering the range of China's territory. From among these, 584 frames were selected. With respect to them, there were differences in the time periods they were taken from. However, due to the fact that the greatest efforts possible were made to select information from the same season, it made landscapes possess seasonal consistency. Through complicated digitized imagery processing, mosaics were formed into a complete pannaional color map. The scale is 1:1000000. Moreover, mosaics achieved flawless results. The full map area is 6x6 square meters. Besides this, corresponding 1:2500000 and 1:4000000 maps as well as 1:1000000 land utilization maps of the whole country were produced. In addition, land type maps and grassland resource maps were also prepared. This is a great achievement by our country in making use of space remote sensing in the areas of map preparation as well as development and utilization.

3. Environmental Surveys. As far as international cooperation with regard to combined global environmental monitoring is concerned, China is in the midst of engaging in regional research. In the Yangtze River valley and the Yellow River valley, stress is laid on regimen monitoring, land utilization, as well as the differentiation of economic areas. In the northwest region, particular emphasis is laid on the areas of grassland dessication characteristics, deserts, and

desertification. In the case of the Qinghai-Tibet plateau, such research is done as on the metrological environment as well as geomorphological characteristics, and so on. We already make use of space remote sensing materials to carry out scientific research associated with such things as economic planning with regard to the Yellow River-Huai River-maritime region, grassland surveys of the northwest region, loess plateau soil erosion, as well as forestation results associated with the three northern protected forests. A series of results have been obtained having reference value in economic terms.

4. Disaster Monitoring. In 1987, the Daxingan Range gave rise to a great forest fire. Its broken up nature was discovered, first of all, by metrological satellite observations of the surface. After that, comparatively detailed imagery of the fire path was obtained from satellite surface stations, providing information for command and control associated with the fire situation. With regard to forest damage situations after great fires, these are also obtained by analysis of satellite remote sensing data, and samplings done for results conforming to typical on site surveys, thereby supplying a scientific basis for management after disasters. At the present time, forest management departments already use space monitoring to act as a routine measure associated with forest fire prevention. In conjunction with this, practical results have already been achieved.

We are cooperating with Japan and will distribute data associated with test measurement stations at crucial locations. At times when satellites cross over borders, transmissions are made up to satellites. After that, recoveries are made at command centers to carry out commands. This is nothing else than the satellite data collection system. In 1990 and 1991, when the Yellow River and Yangtze River valleys gave rise to flood disasters, we used airborne microwave radars to carry out remote sensing tests. (This type of remote sensing means is not subject to limitations associated with overcast and rain, is all weather, and is appropriate for use in playing a role when one has the appearance of bad weather and flood disasters). Through data analysis and processing, communications satellites take information and send it to the flood fighting headquarters. It is possible to get imagery displays within 5 hours. It is, thus, possible to make use of geographical information prepared in normal times relying on satellite remote sensing--obtaining accurate regimen forecasts.

## II. Space Technology Applied to Map Making Technology



The U.S. GPS (Global Positioning System) satellite group is a total of 24 satellites. No matter what point it is on the globe, it is, in all cases, possible to make use of these satellites to carry out positioning. Accuracies reach a number of meters. This has already become a commercial means (positioning equipment is on sale). In the skies, the former Soviet Union also has a similar system. China's map making survey agencies make use of this positioning method to carry out positioning of geodetic network measurement points. Precisions are ten times higher than in the past. For example, Shen (illegible) City's GPS satellite positioning net accuracy reached 3.2 centimeters.

As far as foreign launched telemetry satellites are concerned, they specialize in precise measurements associated with satellite orbits. Moreover, they are capable of being used to measure prolonged shifts associated with surface survey points. A laser satellite telemetry system set up at China's Shanghai Observatory is used for high power frequency multiple YAG laser pulses and telemetry gate technology. Some improvements have been gone through. Accuracies have risen from 15 centimeters to 2 centimeters, reaching advanced world levels and sufficient to enter into the ranks of international telemetry. Using international cooperative experiments precisely calculating movements of the earth's plates to act as precise measurements of plate boundaries, year after year, accumulations and regressive calculations have already initially displayed movement trends associated with the earth's plates (generally, on the order of one centimeter/year). It is possible to see that this is a basic scientific research project which is related to the survival of mankind and long term changes in the earth.

### III. Influences of the Space Environment and Microgravity on Matter

Making use of specimens carried on returnable satellites to carry out space environment experiments possesses the advantages associated with research and analysis carried out on samples brought back in a timely manner. We have already carried out a number of iterations of space microgravity scientific experiments. First, is growing semiconductor crystal materials in space. As far as growing this type of crystal on the surface is concerned, due to influences of gravity, there will be produced, during growth processes, constituent layering and convection phenomena associated with melted fluids. With regard to products with relatively large volumes and crystals with high degrees of uniformity, it is difficult to overcome the difficulties. However, under microgravity conditions in space--producing crystals in melted liquids--it is possible to very,

very greatly reduce these perturbing factors and arrive at high quality crystals. Making use of satellite borne experiments on returnable satellites, we have achieved gratifying results. In particular--in terms of arsenic and gallium crystal growth--it was not only verified that it was possible to produce high quality crystals. Moreover, going through various types of test measurements--even to the point of finally using them to manufacture products--everything spoke to their effectiveness. This work achieved a high degree of serious attention internationally.

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Various types of plant seeds were carried into space. After a period of time had passed, the satellite subsequently returned.

Going through cultivation of the seeds, a good number of curious phenomena were discovered. For example, a strain of rice unexpectedly came out as one stalk with multiple ears. It would seem that this is due to genetic phenomena given rise to by irradiation from the radioactivity in space. This has then provided a new path for genetic breeding.

#### IV. Exploration of Physical Parameters Associated with Space Environments and the Physics of Space Environments

Due to unceasing progress in astronavigational technology--including problems associated with carrying people--studies of



Fig.1 The Weaver Girl No.3 Sounding Rocket During Launch

the physical environment of space as well as normal and safe operations for spacecraft possess very important significance. In particular, the solar wind and electromagnetic radiation, possessing high speed particles radiated out due to activities associated with the sun, lead to the formation of and changes in such things as magnetic layers and ionization layers in space. These are capable of influencing the normal operations of instruments on satellites as well as the health and safety of astronavigational personnel. This area still has a good number of problems which await exploration. In regard to China, using rockets to carry out this research had begun before artificial earth satellites had yet appeared. This type of research work has continued right along up to the present. Our space physics research personnel--under conditions where experimental research is extremely difficult--made unremitting efforts, including making use of foreign materials and also doing work with a certain significance.

China's earliest engagement in geomagnetic observations began with the establishment (in 1874) of Shanghai's Sheshan geomagnetic station. In the 1930's, explorations were then begun into research on the ionosphere. Since the activities of the

International Geophysical Year, China has constructed--one after the other--a good number of surface observation stations. In particular, there is the "China Meridian Plane Observation Chain" at 120°E. In this are included observatories, ionosphere measurement stations, cosmic ray observation stations, electromagnetic stations, and so on. Besides these, the Zhongshan Station and the Great Wall Station have been set up at the two poles. All these have intimate relationships to the physical environment of space.

Beginning in 1960, China has launched sounding rockets for a total of 260 rockets of 18 types. Among these, 6 types are specialized high altitude metrological and space physics services. In 1988, a low latitude comprehensive launch base was set up on Hainan Island in order to expand the scope of research associated with space physics.



Fig.2 Metrological Microgravity Experimental Capsule (Illegible)

Beginning in 1977, high altitude scientific surveys were carried out, reaching 170 iterations. The globe is a zero pressure form. Volumes are 30 thousand square meters to 300 thousand square meters. Maximum altitudes reach 40 kilometers. Loads can reach 600 kilograms. From 1986 to 1988, cooperation was made with Japan to carry out transoceanic observations. Recently, there has been cooperation with Russia to carry out research--through long range flights--on cosmic rays and rays coming from the sun as well as nonsolar X-rays, and so on. Scientific survey satellites were launched in 1971 and 1981. Another satellite will soon be launched again. It is particularly worthwhile bringing up the fact that two metrological satellites were launched making use of piggy back means in 1990. These were used in order to study vertical

distributions of atmospheric densities pertaining to the range of space, obtaining data with great reference significance. In conjunction with this, observations were made of such influences as those due to atmospheric moisture and leading to changes with an undulating character.

As far as the area of space physics is concerned, China--with the assistance of data supplied by foreign cooperation--has done a good deal of research work possessing an international level in such areas as solar physics, interplanetary physics, and--in particular--magnetic layer and ion layer physics associated with the physics of space in the sun and the earth. Recently, in the area of satellite research (CLUSTER)--taking as the objective the exploration of microstructures associated with layers in the sun and the earth--cooperation is just being carried out with the European Space Agency.

Making use of space means, China has also carried out--to a certain extent--research work in regard to the ozone layer, the CO2 greenhouse effect, as well as observation of ocean currents along China's sea coast, and space astronomy. /16

Summarizing what was described above, the work in areas of space science, which we carry out--to a very great degree--is geared toward our economic construction. Part of the accomplishments in it have won for China an international position in space science. As far as the reforms and opening up which are going on at the present time are concerned, in terms of the economic system, in the environment of the transition associated with switching from a planned economy to a socialist market economy--and due to the strongly fundamental nature of this work--it is very difficult to directly reap economic benefits from it. Although there are some projects which get support from natural science funds as well as fixed funds, the inputs are very scarce. In terms of a good number of problems, ability does not match ambition. With respect to Chinese investment in the field of space science, investments in areas of space science technology are far lower than those of other advanced nations. As a result, considerably improving this proportion--making space technology possess a higher useful value and benefit--is a problem which must command attention in terms of political policy.

(This article taken from <<Zhongguo Kexue Bao>>)