

STAMATIOS M. KRIMIGIS

GUEST EDITOR'S INTRODUCTION

This issue of the *Johns Hopkins APL Technical Digest* completes the series of articles, begun in Volume 5, Number 4, describing research and development activities in the APL Space Department. The emphasis here is on spaceborne and ground-based instrumentation and techniques.

The beginning of the instrumentation effort dates back to 1960, with the arrival at APL from Yale of G. F. Pieper and C. O. Bostrom to measure and study the radiation environment of the Transit satellites, which were expected to operate for 5 years or longer. Together with the late A. J. Zmuda, they are responsible for the first use of solid-state radiation detectors in space, on the University of Iowa satellite, Injun I. (Incidentally, I used the APL data for my M.S. thesis at Iowa in 1963 under the auspices of J. A. Van Allen.) This group, with D. J. Williams (who joined it in 1961), was responsible for other detectors flown on several APL-designed and -built satellites with such arcane names as TRAAC (1962), 5E-1 (also known as 1963-38C), 5E-5 (1964), and DODGE (1967), as well as on Injun III, another University of Iowa satellite. Each experiment broke new ground either in experimental technique or in unique discovery, for example, the first neutron detector (TRAAC),¹ the discovery of field-aligned currents (1963-38C),² the first ultraviolet survey of the sky (5E-5),³ and the first color picture of the full earth from space (DODGE).⁴ Since those early days, our instrumentation and data analysis efforts have expanded tremendously, with APL participation in many National Aeronautics and Space Administration and Department of Defense spacecraft covering a broad range of activities from particle, plasma, and magnetic field instrumentation to auroral imaging, radar ionospheric and atmospheric studies, and oceanographic and altimeter research. Several applications in the area of technology transfer also resulted.

We begin this issue appropriately enough with an article on cosmic rays and the heliosphere by a long-term collaborator and current sabbatical visitor, D. Venkatesan of the University of Calgary, Canada. (It is of interest that cosmic-ray studies were first performed at APL under the direction of J. A. Van Allen using V-2 rockets immediately after World War II.) His article is followed by a description by Jaskulek et al. of the latest developments in energetic particle instrumentation, recently flown on AMPTE/CCE

and scheduled for flight on Galileo and Solar Polar spacecraft in 1986.

The Hopkins Ultraviolet Telescope (Davidsen and Fountain), also scheduled for flight in 1986, is an example of the close relationship between APL and the Homewood Campus of The Johns Hopkins University, which has resulted in such experiments as the Apollo-17 ultraviolet spectrometer and a similar instrument for the Apollo-Soyuz mission flown in 1975.

The next article describes the use of radar techniques in probing ionospheric irregularities, a method developed by Greenwald while he was at the Max Planck Institute for Aeronomy, in West Germany.

The article on the Space Telescope fine guidance sensor (Griffin et al.) illustrates another aspect of the Department's work: applying a combination of computer simulation and state-of-the-art instrumentation to a most difficult problem in pointing and control.

The transfer of space technology to applications not involving space is illustrated in the next two articles. Black and his colleagues discuss the use of a space-developed transmitter to study the migratory patterns of birds, while Newman describes the design and development of several biomedical devices. The latter are the latest in a series of medical electronic devices, based on highly reliable components, that began with the development of the rechargeable cardiac pacemaker and include the Programmable Implantable Medication System (for which R. E. Fischell and his collaborators recently received the NASA Space Act Award).

The article on precision time and frequency systems (Rueger and Chiu) highlights the fact that state-of-the-art time and frequency standards are an essential element underlying all modern spacecraft systems and instrumentation. The standards also have important scientific applications, such as measurements of relativistic quantities in strong gravitational fields, as contemplated on a possible Solar Probe spacecraft.

It is appropriate that the concluding article concerns the Kershner Space Systems Integration and Test Building (Bush et al.), for without appropriate facilities, it is impossible to build spaceborne instrumentation that can meet the extremely high standards of today's technology.

Other contributions in this issue are directly related to the subject matter of the theme articles. The summary of a conference on "Frontiers of Remote Sensing," organized by APL for the International Union

of Radio Science, illustrates the importance we attach to that discipline with so many potential applications in both civilian and national security areas.

The review of two books authored or co-authored by APL scientists in the area of space plasmas indicates the high-quality research and scholarship of the Space Department's programs. It is appropriate that these books are reviewed by Hannes Alfvén, Nobel Laureate in Physics, who is the intellectual mentor of the field of space plasma physics and who predicted the presence of field-aligned currents several years before they were discovered by an APL spacecraft.

The article on "High Altitude Research at APL in the 1940s" by Fraser, the Venkatesan review of Van Allen's book on the "Origins of Magnetospheric Physics," and the "Work in Progress" account on the AMPTE spacecraft preliminary results are all interconnected by a common heritage stretching over a period of 40 years. For it was Van Allen's work at APL with V-2 and Aerobee rockets that established the tradition for subsequent developments in particle instrumentation that eventually led to the discovery of the Van Allen belts described in his book. The review by Venkatesan, a University of Iowa faculty member when space exploration was just beginning, gives a measured perspective of events of that era, which only an active participant can provide.

The news item on AMPTE, a three-nation magnetospheric program described in more detail in previous issues of the *Technical Digest*, relates to some of the first questions raised after the discovery of the Van Allen radiation belts, i.e., the origin and nature of the particles constituting the trapped radiation. In a "Symposium on the Exploration of Space," held by the National Academy of Science on April 29-30, 1959, and documented in the November 1959 issue of the *Journal of Geophysical Research*, reference is made by John Simpson to a suggestion of Philip Morrison regarding the possible presence of helium nuclei in the radiation belts and of heavier nuclei as well, in the tens of megaelectronvolts range. Van Allen responded⁵ that "...we should consider particles in the tens of kilovolts, actually." Five years later, an experiment of mine, performed at Van Allen's suggestion, identified alpha particles in the magnetosphere in the few hundreds of kilovolts range. And just a few months ago, the instruments on the APL-built Charge Com-

position Explorer spacecraft of AMPTE achieved unique identification of alpha particles and other heavier ions in the tens of kilovolts range, some 25 years after the suggestion of their presence was first made.

We have now come full circle and are providing answers to questions articulated a generation ago. These answers became possible only by continuously pushing the frontier on instrumentation, in an environment that fosters innovation, encourages inventiveness, and rewards risk-taking and hard work.

REFERENCES

- ¹D. J. Williams and C. O. Bostrom, "Albedo Neutrons in Space," *J. Geophys. Res.* **69**, 377-391 (1964).
- ²A. J. Zmuda, J. H. Martin, and F. T. Heuring, "Transverse Magnetic Disturbances at 1100 km in the Auroral Region," *J. Geophys. Res.* **71**, 5033-5045 (1966).
- ³A. M. Smith, "Stellar Photometry from a Satellite Vehicle," *Astrophys. J.* **147**, 158-171 (1967).
- ⁴K. Weaver, *National Geographic* **132**, 726 (1967).
- ⁵J. A. Simpson et al., "Symposium on the Explorations of Space—Round Table Discussion," *J. Geophys. Res.* **64**, 1673 (1959).

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STAMATIOS M. KRIMIGIS is chief scientist of the Space Department. He was born in Chios, Greece, in 1938, and was educated at the University of Minnesota (B.Ph. in physics, 1961) and the University of Iowa (M.S., 1963; Ph.D., 1965, both in physics under the direction of J. A. Van Allen). He remained at Iowa as Research Associate (1965-66) and Assistant Professor of Physics (1966-68) before joining APL in 1968.

Dr. Krimigis' research interests include the earth's magnetosphere, the sun, the interplanetary medium, and the magnetospheres of the planets. He has been the principal investigator or co-investigator on several NASA spacecraft, including the Low Energy Charged Particle (LECP) experiment on Voyagers 1 and 2, and is presently principal U.S. investigator for the Active Magnetospheric Particle Tracer Explorers (AMPTE) program. The LECP experiment and AMPTE satellite were designed and built at APL. Dr. Krimigis has published more than 160 papers, has been awarded the NASA Medal for Exceptional Scientific Achievement, is a member of the National Academy of Sciences' Space Science Board, Chairman of the Board's Committee on Solar and Space Physics, a Fellow of the American Geophysical Union and the American Physical Society, a member of the Citizen's Advisory Committee for the Congressional Caucus on Science and Technology, and a newly elected member of the APL Advisory Board.