

## Introduction

### Jules Aarons – Space scientist and mentor

#### Guest Editorial in Honor of Dr. Jules Aarons

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It is fitting that the session on “Equatorial and Low Latitude Aeronomy” at the joint EGS/AGU Meeting in honor of Dr. Jules Aarons was held in Europe. Indeed, he was a pioneer in beacon satellite studies of the ionosphere and involved many European nations in that effort. Aarons’ association with European scientists started early when he spent several years in France to complete his doctorate at the University of Paris under Prof. E. Vassy in 1954. This European collaboration flourished greatly when, as an Air Force Cambridge Research Center scientist, taking advantage of the launch of the Sputnik series of satellites in 1957, he formed the Joint Satellite Studies Group (JSSG). The primary objective was to foster the collaboration of primarily NATO country scientists in the study of atmospheric effects on satellite signals on a quasi-global basis. He had a long association with AGARD, the NATO Advisory Group on Aeronautical Research and Development, and was the Chairman of its Electromagnetic Wave Propagation Panel.

Aarons’ name has now become synonymous with the field of ionospheric scintillations. He showed that it is possible to make a meaningful study of plasma structuring in the ionosphere utilizing a beacon in the sky, and only simple receiving systems on the ground. This allowed many developing countries to participate in this enterprise and necessitated the expansion of the JSSG to include many non-NATO countries in a truly global effort to understand scintillation morphology and its impact on communication systems. Thus was born the Beacon Satellite Studies (BSS) Group, with its first meeting at Graz, Austria, in 1972 under the Chairmanship of Prof. R. Leitinger of the University of Graz. This group remains active to this day with bi-annual meetings having been held in many different venues in Europe, several in the Boston area in the US, and in Argentina, India and China among others. A session similar to this EGS/AGU one was held in Aarons’ honor at the last BSS Group Meeting at Boston College in July 2001 with the Proceedings of the Symposium featuring a warm tribute to him written by his long time associate J. A. Klobuchar.

Aarons has published more than a hundred papers and edited a book on Radio Astronomical and Satellite Studies of the Atmosphere to elucidate the scintillation phenomena. He began his studies at middle and auroral latitudes, first using radio stars and then satellite beacons, to define an equatorward boundary for high latitude scintillations. He showed that the VHF scintillation boundary was more equatorward of the low-energy particle precipitation boundary and its dynamics was controlled by magnetic activity. From that vantage point, he extended his studies both to polar and equatorial latitudes. He was the first to point out that there were large scintillations in the polar cap ionosphere, especially during years of maximum solar activity. He was also the first to point out that low latitude scintillations did not maximize at the magnetic equator, but at the crests of the equatorial anomaly in F-region ionization. He encouraged and supported the construction of many ionospheric monitoring stations, in collaboration with numerous colleagues from around the world. With the advent of geostationary satellites, Aarons immediately recognized the value of time continuous total electron content (TEC) and scintillation measurements at these various locations. His foresight and vision in setting up these stations greatly improved our worldwide

understanding of scintillation morphology and TEC variability. In particular, his research on equatorial scintillations, combined with radar and satellite in-situ measurements provided much insight into the physics of plasma structuring, an endeavor in which Santimay Basu and myself were active partners. It is quite instructive to recognize that because of the far-flung stations he established, his Laboratory could help the Air Force in its planning for space-based communication and navigation systems. For instance, Klobuchar, working with Aarons developed an algorithm to reduce by approximately 50 per cent the ionospheric range delay errors in single frequency Global Positioning System (GPS) receivers for navigation. This model is still in use by the GPS system twenty five years after its development. Thus this group's research on ionospheric physics and their systems applications laid the foundation for what is known today as ionospheric space weather studies. In the larger context of the Sun-Earth system, space weather research with its societal benefits has now become a topic of great interest to the global community of space scientists and the civilian and defense agencies that support their work.

Given his international outlook, Aarons was able to attract scientists from all over the world who were eager to benefit from the global archive of scintillations and TEC data he had so assiduously built. His Laboratory played host to a galaxy of foreign associates and, of course, several from within the US as well. These people generally visited for extended periods of time as the US National Academy/ National Research Council scholars. In addition to many European scientists, he welcomed colleagues from as far away as India, Australia and Israel, to name a few. His long-term guidance and mentoring of these colleagues and their mutual interactions have transformed the Beacon Satellite Studies Group into a close-knit international community.

During his tenure of more than thirty years as an Air Force scientist, Aarons was recognized with the Exceptional Civil Service Award and the Gunther Loeser award for scientific achievement. His alma mater, the City College of New York, honored him with the Townsend Harris Medal. Aarons was very active in professional organizations such as the Institute of Electrical and Electronics Engineers (IEEE) and the International Scientific Radio Union (URSI). He was elected a fellow of the IEEE and honored with its Harry Diamond Memorial Award. He served both the US and the International Committee of URSI as the Chair of Commission G on Ionospheric Radio and Propagation.

After his formal retirement in 1981 from the Air Force Geophysics Laboratory, as it was then known, he joined Boston University as a Research Professor in the Department of Astronomy with close ties to the Center for Space Physics.

His wise counsel is much appreciated by faculty and graduate students alike. At Boston University, working closely with Prof. M. Mendillo, he launched scintillation studies using a worldwide network of stations monitoring the GPS satellites. His major interest has been to elucidate the effects of magnetic storms on the equatorial and high latitude ionosphere by the use of transmissions from these satellites and other supporting measurements. This phase of his career, which is happily continuing in the ninth decade of his life, has been very fruitful producing more than 30 journal publications. During this post-retirement period, the prestigious Appleton Award of the Institution of Electrical Engineers (IEE) was bestowed on him in 1996. His insatiable thirst for knowledge, his personal warmth and genuine concern for colleagues from around the world remain the hallmarks of his long career.

Aarons is one of those rare individuals who has not only been recognized as a distinguished physicist but has also been highly acclaimed as a talented photographer. He always felt a creative impulse that science alone could not satisfy. However, his scientific pursuits allowed him to travel widely, so that this self-taught photographer could indulge in his passion for street photography, not only in the ethnic neighborhoods of Boston, which have long vanished, but also in Europe, South America and Asia. He has had photographs in the collections of the Museum of Modern Art (New York), Bibliotheque Nationale (Paris), the Museum of Fine Arts (Boston) and has had one-person photographic shows at galleries in the Boston area, New York, and Paris. Earlier this year a retrospective of his photographs over thirty years was exhibited at the DeCordova Museum in Lincoln, Massachusetts. In the Introduction to his recently published book on "Street Portraits, 1947-1976: The Photographs of Jules Aarons", the Curator of the DeCordova Museum, Rachel R. Lafo wrote "Aarons' interest in and empathy with his subjects enabled him to capture quotidian moments that resonate with a *joie de vivre*, whether the subject is a street performer in Paris or a girl running down the sidewalk in Boston. Even though he was not trained as an artist, Aarons quickly mastered the technical aspects of photography, producing images with dramatic shadows and highlights, formally structured compositions, and timeless presence."

Jules Aarons' colleagues, admirers and friends from all nations wish him many more years of dedicated involvement in the arts and sciences!