With Riccardo Giacconi at AS&E and CfA

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Riccardo Giacconi belongs in the categories of the most successful and most versatile astronomers of the last third of the 20th century by virtue of his contributions to X-ray Astronomy at AS&E/CfA, his contribution to optical astronomy as director of STSI, and of ESO, and to radio astronomy as director of Associated Universities who are responsible for the US role in ALMA. Nobody else has displayed such versatility.

He inspired and motivated all who worked with him to do their best.

I describe my experiences working with Riccardo Giacconi at AS&E and CfA.

I met RG in September 1962 after returning from a 2 year Post Doc position in Frascati, Italy (about 20 km from Rome) where I worked at a high energy particle accelerator. The campus was at the time also the base of the Rome astrophysics group. Their main activity was searching photographic plates for evidence of the existence of neutron stars.

At the end of my Post Doc period I was forsaking high energy particle physics and was not interested in an academic career. I thank George Clark whom I met during my gradate school days at MIT for suggesting that I apply for a job at American Science and Engineering (AS&E), a small but growing company then situated in temporary buildings on the MIT campus . This was the only occasion throughout my entire professional career that I ever sought employment.

Riccardo hired me along with several others about three years after the discovery of the first cosmic X-ray source, Sco X-1. During the time between the discovery of Sco X-1 and my joining AS&E more cosmic X-ray sources had been found from rockets flights of several groups. By fall of 1965 about 20 sources, some variable, had been detected during ~1 hour total observing time, from all labs combined. All were poorly positioned. RG understood that the only way to understand the nature of the cosmic X-ray sources was to refine their positions to about one arc minute so that their optical counterparts could be identified and studied. New type instruments were needed to accomplish that. Higher resolution focusing X-ray telescopes did not exist at that time,

I was fortunate be assigned to an AS&E/MIT rocket program that featured a new, unique collimator designed by Minoru Oda of Japan (who was visiting MIT). Herb Gursky of AS&E added a feature that improved position measurements by a factor of three in each dimension. My contribution was improving the performance of the gas proportional counters and accompanying the rocket payload to the launch station in White Sands, New Mexico. The rocket flight went very well. The X-ray position of Sco X-1 was obtained soon after with an error of about an arcminute.

Riccardo had engaged optical astronomers, Alan Sandage of the Mount Palomar Observatory and a Japanese group to find the optical counterpart of Sco X-1. They would

be provided the X-ray position of Sco X-1 to search for its optical counterpart. The Palomar astronomers concluded that the optical counterpart had some of the characteristics of an "old nova". That did not satisfy our search. However, about a year later a Russian theorist, Yossef S. Sholvsky, deduced from the X-ray and Optical data that Sco X-1 was a close binary system with an accreting neutron star. This was the first evidence for the existence of neutron stars and was probably an important factor in Riccardo being awarded a Nobel Prize in 2002.

Even before the identification of a neutron star RG had been urging NASA to support an X-ray astronomy satellite program. They were finally convinced and began the Small Astronomy Satellite or SAS program. AS&E proposed and was awarded the first SAS mission (SAS-A), which consisted of simple scanning collimated gas proportional counters. After launch in December 1970 in Kenya SAS-A was renamed"Uhuru", after the Swahili word for freedom. Uhuru found and catalogued some 340 cosmic X-Ray sources including more close binary systems, low and high mass. (Some twenty years later ROSAT with a focusing high resolution X-ray telescope found and positioned over 100 K sources.)

RG told me that his interest in focusing optics began during his experience with cloud chambers studying cosmic rays and his frustration over the low rates of cosmic rays. He thought about gathering in a larger angular range of cosmic rays by focusing, which was not possible.

From the late 1960's through 1977 I directed a sounding rocket program that used focusing X-ray optics. Its success helped give credibility to a HEAO-2 proposal submitted by a collaboration led by RG at AS&E. It contained a high resolution 0.6 m diameter focusing X-ray telescope and multiple detectors. It was launched late in 1978 and renamed by RG as the Einstein Observatory.

RG campaigned for the establishment of the Guest Observer Program, and the General Observer Programs, now standard practice by NASA. For particular missions, anyone could propose an observation. The PI of an observation would have exclusive rights to the data for only a limited time, ~a year. It was then made available with funding to those whose observing proposal was selected.

RG was already considering a higher resolution 1.2 meter telescope with more advanced detectors that propelled the beginnings of the Chandra X-Ray Observatory.

In 1972 The Center for Astrophysics was created by combining the Harvard College Observatory with the Smithsonian Astrophysical Observatory with both having the same director. Riccardo was offered a Harvard professor position plus several permanent federal positions for scientists he could choose. I was offered one of the federal positions. Riccardo told me "I will go to CfA even if no one else is willing to leave AS&E. If that happened I will start all over again with Bill Forman" (who was already at Harvard).

Many AS&E scientists did choose to go to CfA starting in July1973 ; several NASA contracts were transferred to CfA from AS&E. There were successful rocket flights with X-Ray optics and the Einstein Observatory with a 0.6 m diameter X-ray telescope was launched.

RG wanted to create an "X-ray astronomy institute" similar to the Space Telescope Science Institute. However, NASA would not support it. Also CfA was not fully in accord with hosting it.

A few years later I was in RG's office when our meeting was interrupted by a call to RG from John Bacall. RG was being offered the position of the first director of the Space Telescope Science Institute plus a professorship at Johns Hopkins.

He accepted knowing he was leaving the development of the next generation high resolution 1.2 m X-ray telescope mission, which became the Chandra X-Ray Observatory, in good hands with Leon Van Speybroeck as the telescope scientist, Harvey Tananbaum directing the substantial CfA effort, and Martin Weisskopf as the Marshall Space Flight Center Project Scientist.

As everyone here knows he was very successful in all his ventures after leaving CfA. That included being Director of the Hubble Space Telescope Science Institute, Director of the European Southern Observatory, which developed the Very Large Telescope and as President of Associated Universities, which has the responsibility for managing the US participation in ALMA, a large array of radio telescopes in Chile.

He had a prominent role as director of a prominent research center in all three major branches of astronomy: X-ray, optical, and radio. Therefore I consider him to be the most effective astronomer of our time.