Comments at the Banquet and Conference Conclusion

by James Moran

I'm going to take my prerogative as one of the gray beards of the project to ramble a bit.

I'll start by saying that I have been tremendously impressed with the quality of the talks at this meeting. I heard every talk at this conference (I think only You Hua-Chu can also make that claim). Every one held me in rapt attention. Even Fred Lo, aka "Mr. So-What?," was very impressed.

The SOC strongly recommended that opportunities be given to the younger members of our community to participate and speak, and I am very pleased that that happened. Here are some of the demographics. More than half of the 106 participants were under 40. The gender breakdown was 75 men and 31 women. We had 13 invited talks, and all of our first choice invitees accepted. Eight were younger than 40, and the gender distribution was 8 men and 5 women. The participants came from 35 institutions, 13 of them outside the United States. The CfA had 52 participants (including 31 SMA project members), and ASIAA had 9. I am also pleased to note that currently there are five graduate students in the PhD program at Harvard (about 10% of the total complement in the astronomy department) for whom SMA data will form a major part of their dissertations.

When we envisioned the SMA in the mid-1980s, the scientific landscape at submillimeter wavelengths was virtually uncharted. As a result, the scientific achievements of the SMA are not well reflected in the project's rationale, which is true of most major new instruments. Several examples come to mind. Few could anticipate that voids in protoplanetary disks could be imaged. The IRAS results were just becoming available, so few could have anticipated the work that the SMA would do on the study of gravitational lens–boosted emission from high-redshift dusty galaxies. The existence of a black hole in the Galactic Center was unproven. Who would have expected that SgrA* would become transparent to the plasma turbulence blurring its image at submillimeter wavelengths so that the black hole's accretion envelope could be studied by VLBI at 230 GHz and higher?

I have been particularly impressed by the polarization work that has been done with the SMA, which tells us so much about the magnetic fields in sources. The origin of the polarization capability on the SMA is an interesting story. The initial proposal for the SMA, aka the "yellow book" (Moran et al., SMA Technical Memo 0, 1984), mentioned polarization only briefly in connection with synchrotron sources in AGN and emission from planetary surfaces. However, by the time of the design study in 1992, the cryostat envisioned had room for eight receivers and dual IF systems so that polarization could be accommodated by running two receivers at the same frequencies. In 1998, a workshop was convened at CfA by Alyssa Goodman to discuss the importance of the implementation of polarization capability on the SMA, based primarily on the expected polarization from dust and molecular gas (see Wilner, SMA Technical Memo 129, 1998). However, polarization was a low priority at the time because of the intense effort to bring the basic SMA online.

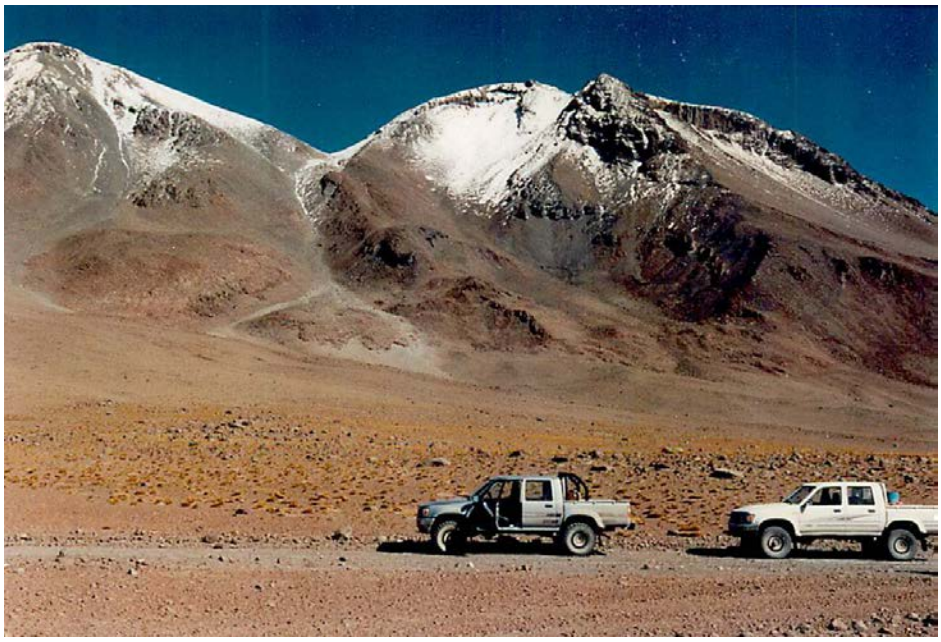
By the time of the Galactic Center meeting in Kona in 2002, it was clear that SgrA* had very interesting linear polarization properties. I came back from that meeting full of enthusiasm about what the SMA might be able to do during the period of basic construction. Since the polarized signal was only a few tens of milliJanskys and a few percent of the total flux density, there was skepticism that any simple system could be implemented with sufficiently accurate calibration to make the measurement. The SMA had only single-channel receivers at 230, 345, and 690 GHz with fixed (with respect to the local horizon) linearly polarized feeds. Attempts were made to derive linear polarization parameters from the diurnal variation in parallactic angle. It soon became clear that the short-term polarization variability made this method impossible. However, it was well known that interferometers with crossed circular feeds were ideal for detecting weak linear polarization because such systems, with perfect feeds, had no response to unpolarized and circularly polarized emission.

Dan Marrone was a third-year graduate student at the time and had just finished up his project to build a THz receiver for the Receiver Lab's telescope in Chile. He seized on the idea of building quarter-wavelength plates at 230 and 345 GHz that would convert the sense of polarization of each antenna to either left- or right-handed circular polarization. Each antenna was switched between RCP and LCP in sequences controlled by Walsh functions such that after about 20 seconds, cross-correlated visibility data could be acquired in all four senses of polarizations (RR, LL, RL, and LR) on all baselines. From these data, images in the conventional Stokes parameters could be made. This was basically the system proposed by the polarization workshop and also implemented on the BIMA array by Ram Rao and others.

Marrone built and installed the polarizers, and we were able to make separate estimates of the angle of linear polarization at the two sideband frequencies in the 230 GHz band and thus to robustly determine the rotation measure characterizing the Faraday rotation phenomenon. These data provided the first definitive measurement of rotation measure in SgrA* free of concern of the problem of comparing measurements made at different epochs and frequencies, which were affected by time variability. This system immediately enabled the exciting polarization work on molecular clouds that you have seen at this conference. The SMA has only recently been able to implement the intended dual-receiver system, which is intrinsically more sensitive because the Walsh switching is not required.

An important lesson we learned about building a new telescope was the great value of the support of the radio astronomy community. We benefitted enormously from the knowledge of our colleagues, which was freely and generously shared. The guidance from our scientific advisory committee, which met annually and was chaired for more than a decade by Jack Welch, was also extremely important. We did an optimization study to determine the antenna diameter, which involved tradeoffs between large antennas favored for reducing the cost of the receivers and increasing baseline sensitivity, and smaller antennas favoring larger field of view and smaller cost per unit of collecting area. The minimum cost was at an antenna diameter of about 7 m, but it was a very broad minimum. We settled on 6 m. In retrospect, I think Jack influenced this decision a lot. Many of the project's early hires came with lots of experience from other telescope development projects, e.g., Colin Masson from OVRO, Cosmo Papa and Jack Barrett from the radio astronomy group at MIT, Ray Blundell from IRAM, Ken "Taco" Young and Ant Schinckel from CSO. Tom Phillips, director of the CSO, once pined that his job in life was to train people to build other people's telescopes. The partnership formed with ASIAA in 1995 was a major milestone for the project. It has had many foreseen and unforeseen benefits. The establishment of this partnership was greatly facilitated by Paul Ho.

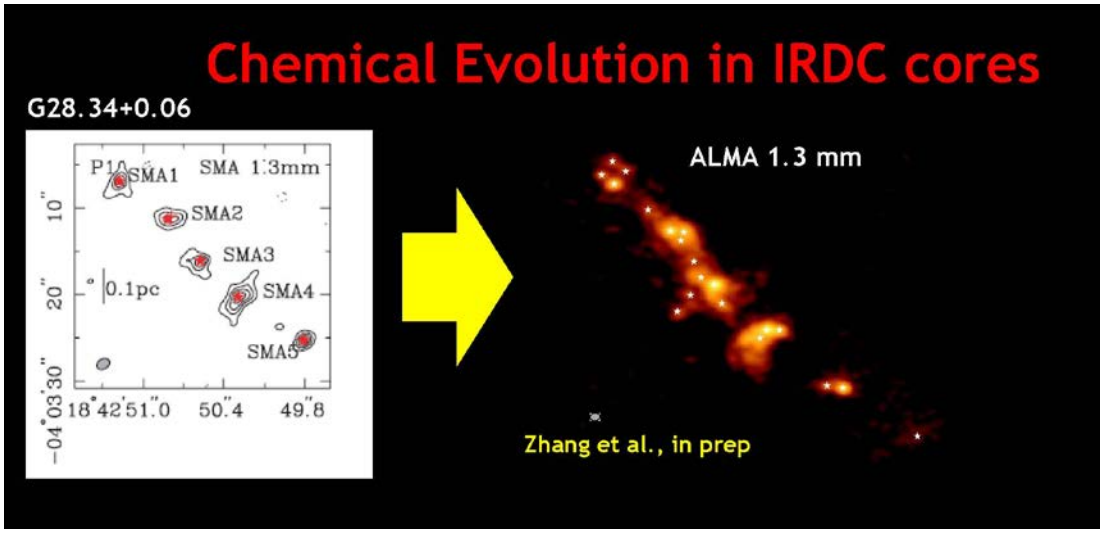
For about a year in the early 1990s, we seriously considered locating the SMA in northern Chile. The IRAM director at the time, Peter deJonge, had considerable experience in Chile working with the VLT site surveys for ESO and told us how dry the conditions were in northern Chile. Ray Blundell, Eric Bloemhof, Doug Wood, and other members of the SMA team became quite interested. We sent a two-person team of Alan Kusunoki and Philippe Raffin to Chile in the Chilean summer of 1992. They scouted out about 20 sites in the regions near Calama, San Pedro de Atacama, and Ollagüe. They were especially enthusiastic about one particular site at 4,650 m elevation near Ollagüe (shown in the figure below and also in the slide show running during the banquet), which unfortunately was reachable only by 100 km of unpaved roads from Calama. While there was considerable enthusiasm among the SMA team about going to Chile, the management at the Smithsonian Institution quickly ruled that the SMA had to be built on a US site. In retrospect, SAO would have really had its hands full developing infrastructure from scratch in Chile. The NRAO search for the site where ALMA would be built started with the SMA study (see Raffin and Kusunoki, SMA Technical Memo 59, 1992). However, the Ollagüe site was quickly deemed too difficult because of the long unpaved road connecting it to civilization.



We were very fortunate to have been able to take advantage of the Mark IV correlator, which was developed primarily for VLBI at Haystack Observatory under a team led by Alan Whitney. Using the Mark IV boards, with their state-of-the-art custom correlator chip supporting a clock rate of 204 MHz, the SMA was able to take a big step forward in terms of bandwidth and resolution. The total capacity of the correlator was 0.9×10^{14}

multiplies per second (a record for radio astronomical correlators at the time!). The correlator needed 2,880 chips procured from a limited production run. We agonized about how many spare chips to buy. Our spares are still in a specially controlled nitrogen atmosphere. As far as I know, we haven't had to use any. With the upgrade of the Naval Observatory's correlator, the SMA correlator will be the last remaining system based on the Mark IV chip.

Now that ALMA is coming on line, one of the SMA's roles will be as its "finder" instrument. We saw many examples of this synergy during the meeting. One such example is the images of the IRDC cores in G28.34+0.6 made by the SMA and also by ALMA in its 16-element cycle-0 mode, which were shown by Izaskun Jiménez-Serra and reproduced below. We look forward to a bright future for the SMA and the continued highly successful partnership with ASIAA. Our immediate goal is to improve sensitivity by increasing the bandwidth and to continue our participation in the EHT.



I'd like to honor a special guest at our conference: Ben Bosma. He was the VP for engineering from 1984 to 2003 at Bosma Machine & Tool Co., a small family-run company in Tipp City, Ohio (near Dayton). It won the contract to manufacture the reflector panels for the SMA, i.e. the "face" of the instrument. There were 72 panels per dish, in 4 different sizes, the biggest being about 1 square meter. The surface accuracy specification was 5 microns rms per panel. Ben invented the cutting process. The cutting tool was mounted on an arm at a length adjustable out to the radius of the dish, and it swung back and forth, slowly removed aluminum from each panel block. He holds a patent on this process for shaping metal surfaces of revolution. Since the time when he was overseeing the panel production, Ben has returned to active duty as a fighter pilot

in the Air Force and has served as an aeronautical engineering consultant for Booz Allen Hamilton.

I want to take this opportunity to thank the people who made this conference possible, all of whom have had long associations with the SMA.

Margaret Simonini joined the project in 1993, 21 years ago, as the first and only project administrator. She has helped many of you over the years with visas and travel arrangements. She is a prime example of the failure of Parkinson's law, which describes how administrative bureaucracy in any project or organization expands over time, regardless of the size of its task, as well documented by the development of the British navy in the early 20th century. She was the financial manager for the conference, and my only complaint is that she didn't let me spend more money. Margaret used to have a staff. Now she does everything herself.

Carolann Barrett has been my assistant since 1984, with a small gap between 1991 and 2009, when she worked at Harvard's Fogg Art Museum. Carolann helped prepare the report of the 1984 committee that proposed the SMA, the "yellow book." It is interesting to note how office technology has improved since 1984. She typed the report on an IBM Selectric typewriter. At every encounter of a Greek symbol, it was necessary to change, by hand, the typing ball of characters. The machine had memory so that versions of the report could be stored. Each iteration was produced by dumping the memory into another typewriter, which typed out the version character by character, much as a player piano plays songs. For this conference, Carolann edited and organized all the abstracts and produced the program material.

Shelbi Hostler has been with project since 2004 and is our most experienced telescope operator. She created the poster that advertised our conference, prepared the historical slide show that has been running during the banquet, procured the participant gifts, and was in charge of the audio-visual equipment for all the oral presentations during the conference.

Pat Mailhot started with the SMA in 1993 and has worked on many software projects. She developed and maintained the website for the meeting, pitched in on many of the logistical details before the meeting, and will assemble the archival material.

Taco suggested that the conference memento be a battery to charge iPhones and other portable electronic gadgets. I thought this idea was rather nerdy. I proposed etched wineglasses. We compromised and purchased 80 of each, expecting to use about 120 for the participants, with the rest going to the SMA staff members. Well, the 80 battery

packs were snapped up immediately on Monday morning before hardly any of the wineglasses.

The Marriott Hotel has done a fabulous job of making the conference a pleasant experience. This was due in large part to the Marriott's event coordinator, Jill Rudnicki. We relied heavily on her recommendations for the menus at the lunches, breaks, and the banquet. She ran interference on many things, advised on room layouts, and showed a real can-do spirit. Marcelo Brionis, the banquet captain, did an outstanding job coordinating the food service. Perhaps the biggest logistical headache of the conference occurred when he switched the order of the three labeled beverage urns for the coffee, decaf coffee, and hot water. Some of us creatures of habit complained that an unexpected fluid emerged from the urn of our choice.

Finally, one of my worries had been that since there are two Marriott hotels in Cambridge, there would be confusion, especially among absentminded astronomers. In spite of all my written admonitions and maps, I know for sure that at least one conference participant showed up at the wrong Marriott. I will keep the person's name a secret.