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CONFERENCE SUMMARY

Donald P. Cox

Department of Physics, University of Wisconsin-Madison, USA

The Plasma 99 conference, on Codes, Models, and Observations, appeared at first sight to have had a widely dispersed scientific content, making a summary almost impossible, at least for me. Feeling rather inadequate to the task at the beginning of the meeting, I polled the attendees via a show of hands and found that only seven would admit to having been asked, before me, to present the summary (and had had the good sense to say no). That being a rather small number I decided that the organizers had had a sufficient confidence in me and I rededicated myself to the honor of this task. (Sadly, Pepe Franco was busy with organizational details at that moment and missed the joke entirely.) Fortunately, by the end of the week I was able to discern the genius of the organizers, and came to a form of synthesis that I at least could enjoy.

My oral summary began with a list of people who had particularly contributed to the successful operation of the meeting and an expression of gratitude to the Local and Scientific Organizing Committees. Special thanks went to Jane Arthur, Luc Binette, Marco Martos, Julia Espresate, Lorena Arias, Anabel Arrieta, Sandra Ayala, Wilder Chicana, Eduardo de la Fuente, Fulgencio García, Luis López, Alberto Nigoche, Eva Noyola, Carlos Rodríguez, Juan Segura, and Lucero Uscanga. I managed to elicit hugs from Jane Arthur and later Julia Espresate in the process of garnering a general acclamation for this tireless group. In retrospect, I should have remembered to thank Pepe Franco and the Instituto, and figured out some way to get a hug from Sylvia Torres-Peimbert as well, but I was nervous about what was about to happen next and ungraciously forgot. So, let me here record said gratitude and apologize for not having remembered at the time to let the rest of the participants express theirs as well. (When I once before failed in such a mission, Carl Heiles jumped up to save the day. Unfortunately, this time he was not present.) But those who were there will likely understand my nervousness and possibly be a little forgiving.

In order to bring to the attention of the participants at the begining of the week that this was not a meeting within specialties, but one which transcended them, I had made a request that during the week each participant provide me with a note about something they found interesting, or a question they would like to see discussed in the summary session, one which specifically involved an area outside their own personal sphere of expertise. I thought in this way that I might be guided to topics of broad interest for the closing discussion. I received several such notes during the week, and quite a few more on Friday, but by then had decided to begin with a different sort of synthesis, one which arose from the many interesting conversations I had had during the week. That synthesis involved several themes, the first of which was

1. DANCING

Following the wonderful banquet in Hotel Cortez, it turned out that the organizers had made arrangements for us to go to a club where very enjoyable dance music was featured. Not everyone went. I did, but found that it was a very good time to switch to 7-Up. The dance went on for a long time and was spectacularly ecumenical. Toward the end I found myself seated near Alberto López as we contemplated youth, beauty, and spirit. He ventured the opinion that a photograph of the dance floor at that moment would be the perfect conference summary. I believed I knew what he meant, and agreed at the time. But by the next morning, or rather, four hours later when it was time to get up for the last day of the meeting, my opinion had drifted some. It is true that the spirit we witnessed, participated in, and drank fully from was an important aspect for us, but not everyone was there dancing, nor should all have been.

I myself found a home in astronomy. I first knew it at the IAU meeting in Australia in 1973 where I found the form of family I had waited for all my life. But the members weren't all the same. Some dance and carrouse, some are retiring away from the podium. But we are a family who needs to understand, and I believe we largely do, that a warm spirit for all of our diverse members is a big part of who we are. It is one thing about our business in which I have always been proud. I don't know Alberto López very well, had not met him before this conference, but I felt that warmth very much from him, right away.

2. INFORMATION OVERLOAD

The second theme was less stirring to the assembled participants, the subject having to do with how we individually cope with the flood of information passing through our lives. Having been around when such information was largely nonexistent, and having become rather comfortable with that circumstance, perhaps I am personally more shaken than the younger people for whom the present day is more the norm. In any case, my attempt to elicit survival techniques from the group led to no useful insights, so we went on to the next theme. (I suspect that the answer, though, is widespread collaboration.)

3. ENTHUSIASM

One of the things I felt and heard most strongly, after my own trepidation, was enthusiasm for the present high rate of progress. The flood of current activity, as represented in the meeting, was distinctly spectacular. There are several broad fronts which I will summarize next.

3.1. *Atomic Data*

Theory, measurement, assemblage, testing against the real world, identification of diagnostics, simplification (condensation) into usable friendly modeling and analysis tools,..., a remarkable renaissance of activity is currently flourishing and carrying us forward into entirely new times, and all aspects were impressively represented at the conference.

3.2. *MHD Codes*

Hydrocodes are everywhere now, but ones which are 3 dimensional, which include MHD with divergence free magnetic fields, thermal conduction, separate electron and ion temperatures, self gravity, radiative transfer, adaptive mesh refinement, sufficient dynamic range for resolution of turbulence, evolution of the nonthermal component (cosmic rays), etc., and are designed for parallelism, are willingly shared and are reasonably well documented are right around the corner, with dedicated folks working feverishly to bring them to our tool boxes. Many aspects are already in place, with hundreds of users. More physics is better, and the sooner the better. (1/1/2000, the promised release date for the new ZEUS, will occur before this volume reaches print!) Again we find ourselves living in times of fantastic potential.

3.3. *Acquisition of Astronomical Data*

Instrument conception, design, development, promotion, flight, calibration, and support with dedication beyond my imagination has led us to a state with ever more amazing acquisition of images and spectra, revealing enormous detail, sometimes with sufficient detail that we are able to decode it via:

3.4. *Comparisons With Detailed Modeling*

Combining tools from the atomic data projects and MHD development, to produce synthetic images and spectra of specific evolutionary scenarios is providing incredibly detailed insight into the nature of the beasts on which recent data has been taken. And this is just the beginning, with several new observational tools up and running and others in the wings, some ready to take the stage even in the next few months. We are most definitely moving beyond the age of the spherical cow.

4. PAUSE FOR AN OBSERVATION OF MY OWN

It is my perception that a lot of the folks developing tools for all of us seem to be happier doing astrophysics, applying the tools. Why is that?

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In order to avoid putting anyone on the spot, I will deflect my example to a nonconference situation. Just this morning I was describing this observation to a friend in my office when a rather famous and relatively young astronomer was standing outside. Overhearing my remark, the external observer immediately responded with considerable passion (Wisconsin is, after all, a passionate land). I don't remember his exact remark, but it was to the effect that in application was recognition.

There are a lot of reasons why application is seductive. It is more fun to talk about with your friends. It gets papers written, bringing both recognition and salary responses. For a lot of people, it is just plain more fun, more exciting, more interesting, for whatever reasons. Yet they spend major portions of their lives in design, construction, and implementation of our tools—whether they be atomic data tools, plasma code tools, MHD modeling tools, instruments of observation, or the software tools making the observational data accessible.

And we often forget to express our gratitude, whether it be verbally, out of basic human recognition for their efforts and sacrifice, or through lobbying for greater recognition of and support for their endeavors.

This meeting was unusually alive with such people, and it was wonderful to have a chance to see their wares, and express our pleasure at their accomplishments.

It was my hope that in highlighting this phenomenon, many more of us would see the need to be more appreciative of these efforts, both for a moment during which we had a round of applause (though there were so many to be on the receiving end that I wondered who besides me would be left to clap), and as a general theme to carry along into our collective future.

A word now from the (slightly) old(er) guy. Absolutely everyone feels underappreciated at least part of the time. Some of us occasionally get the opportunity to feel overappreciated. The former makes a person crabby and sad; the latter makes one feel hollow and fraudulent. It's better just to know when you do good work, to have a few friends who know it too, and not to worry about what others think beyond that. Oh yes, and not to forget this, that part of your job is to remember to be appropriately appreciative of others.

5. RELEVANT TO THAT LAST REMARK, A BRIEF ASIDE: TAKING BABY STEPS

We try to understand how those great mysteries in the sky do what they appear to. Usually we start off with very simple thoughts on the matter. Several of us might try at the same time, with different thoughts. We might get into arguments about who is right. Generally, neither is. One has overlooked this, another neglected that. It is my conviction that, in the end, truth is approached via diffusion, and even then only after the observational and analysis tools have improved to the point that there is almost no room left for excessive naivete.

This situation leads me to several admonitions, involving criticism, listening, and patience.

Criticism. It is my conviction that when you see one of our compatriots commiting errors of neglect, you have an obligation to tell them so, privately, so that if you are correct and persuasive, they have a chance to do better in the next round. But try not to put them on the defensive. Recognize that it is all part of the great diffusion process, and that sustaining openness of minds while biasing the diffusion in a useful direction is your primary goal.

Listening. Pay attention to the data. If it begins to turn against you, it is better to be the first to notice, and humbly readjust yourself to a new perspective. This is easier if you know in advance that your toy models are not likely correct in the first place. They are attempts to understand, not unimpeachable truths.

Patience. A great deal of patience is needed (though not too much or nothing gets done). It takes a long time to improve and promulgate your ideas, even your tools, as handy as they are. You and your wares are not likely to be right, accepted, or appreciated at first, but you can at least be interesting. Tell your friends. Get their criticisms and garner their enthusiasms. Even better, if you can find good enemies, get their criticisms. Listen. Improve. Keep being interesting. Someday, you might even be right, or your products ready. Even then it will be five years before anyone notices, because the rest of us are too busy with our own development.

6. THEORISTS

Almost nothing we know of in the universe was predicted before being seen. Most "theory" is attempted interpretation, twisting our brains and tools to solve a puzzle. It's no different really than trying to figure out how to measure the spectrum of soft X-rays from the diffuse interstellar medium, except in the latter case a detector and payload have to be built, the whole thing set atop a slowly exploding bomb and shot into the sky for a brief but exciting ride, the data collected, the instrument calibrated, the unexpected bugs deciphered, and another shot planned to get it right the next time, and so on. People tell me that theorists are somehow more highly regarded than experimentalists. For the love of God, I've never been able to understand why.

7. IMAGES VERSUS SPECTRA

We heard the usual, "*A spectrum is worth a thousand pictures*", extended by Deborah Dultzin-Hacyan to "*A thousand spectra are worth more than one average spectrum*". After that she showed that from many spectra one could get hints of the image, an image that in her case was totally unavailable because of the extremely small scale being sampled, somewhat turning things around, you might say. One could hear a yearning within the cleverness, for the picture that could never be had. In Madison, Blair Savage is often heard extolling the virtues of spectra. I have never totally agreed with him, but until now could not put my finger on just what bothered me.

At the conference we saw many wonderful images, and then MHD models of systems which closely resembled those images. We saw many wonderful spectra, and the kinds of detailed insight that could be mined from those spectra. I reflected on this, along with the conviction expressed above that almost nothing we know of in the universe was predicted before being seen. I think I finally have it right. We need both, for different reasons:

1. IMAGES are desperately needed for the generation of ideas.
2. SPECTRA are desperately needed for constraint of that imagination.

In either case, higher resolution brings greater access to truth.

8. MORE ON THE MIXED, EXCITING, NURTURING SOCIOLOGY

When I was young(er), I would go to meetings and, apart from giving my own presentation, I wondered about what I was there to accomplish. Of course I was anxious to learn from what others had to say in and after their talks, but I pondered the sociological aspects of the situation. To some extent, I imagined that part of my job was to impress the old guys. Truth be known, I never considered it to be a very substantial part—the old guys always had lots of other folks clammoring for their attention and I never was very inclined to be a valence electron for a Z=18 atom, an old guy being the nucleus. But I always felt their presence to some extent, appreciated their questions, and felt good when their attentions shone on me, however briefly. Then one day they weren't there any more. I felt their absence.

The good news is that over the years I had spent most of my time and attentions on my cohort, the strange and exciting lot of folks roughly my own age. And they were still there, though suddenly we were the old guys, though not all guys. It was a considerable shock; I had simply never considered the possibility that I would outlive my heroes, thereby becoming an elder.

What was my new role, I wondered. Abdication sounded good to me, and I began associating more and more with younger and younger people, who after all are our future, and for the most part our present as well.

Omigosh, I just remembered something! Spitzer's book on Physical Processes in the ISM has the following dedication, "*To the younger generation from whom I have learned so much*".

Heroes, I guess, have blazed trails on more than one mountain. What have they shown us to be useful in this case? Perhaps our role is to try to help those younger people focus their efforts in productive ways and to stand back a bit from the immediate problem or calculation to ask whether the current result makes sense and fits within the larger picture. It involves a bit more than just dancing.

9. AND WHAT ABOUT SCIENCE?

There were, in the end, about fourteen suggestions submitted by the participants for discussion or highlighting, in addition to several more that came to me verbally or through my own impressions. Not all actually got discussed, but the list itself provides a nice perspective on the nature of the meeting and the souvenirs carried away by the participants. In no particular order, the questions and notions are listed below.

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- What are the best bets for the origin of temperature variations in gaseous nebulae, variations needed to match model spectra with observations?
- Why do the models of various systems so often seem to get the [O I] 6300 Angstrom line strength wrong? Are we missing something fundamental?
- Isn't it finally time to abandon the fiction of filling factors and model the complexity we see? How do we do that?
- Could the asymmetries observed in the very faint external halos of many large multiple shell planetary nebulae, attributed to their interaction with the ISM, be used to probe the density distribution of the interstellar medium? Is the apparent fact that 60% show no asymmetry an indication that a similar fraction of the ISM is at very low density, or is it primarily due to the difficulty of seeing the faint haloes, compounded by projection effects? Or are they just not moving through the ISM fast enough to be distorted (5 to 10 km s^{-1} appeared to give noticeable distortions in the models.)?
- If, owing to the general insignificance of thermal pressure anyway, large regions of the ISM could be largely vacant (except for magnetic field and cosmic rays), what would that be like? Vacant old bubbles? Vacant flux bundles? What?
- If the reionization of the universe was as patchy as the models suggest, could there be places that were missed?
- The simulation shown by Dinshaw Balsara appears to vindicate old dogma (astronomical bodies can run dynamos) and violate current dogma (dynamos get gummed up at small scales), indicating that a mean field dynamo is a real possibility. As the calculation resolves the scales within which it was expected to fail, the new dogma must have some holes in it. This is very good news for those of us who hope to understand astrophysical magnetic fields.
- Could the interesting discussion of rapid reconnection lead to an understanding of the power law distribution of solar flares? One participant replied, "I think the answer is yes. If turbulence is a critical component of reconnection, then since the release of energy from reconnection helps drive reconnection in adjacent regions, and one expects the natural emergence of a power law distribution of flares. It's like the old sandpile problem."
- The sobering presentations concerning the inadequacy of our plasma emission codes, and the enormous effort presently underway to rectify that, tying our understanding to laboratory measurements to the extent possible was reflected upon by several participants, with the word "exciting" being common. One was concerned that the developing tools be optimized for application to relatively weak X-ray sources for which nothing better than CCD resolution may be available for quite some time.
- Several people expressed concern, though not with regard to things heard at the meeting, that spectral fitting is often inappropriate, that perhaps some of the analysis tools for X-ray spectra have become too convenient, with people relying too much on them rather than using a more holistic modeling scheme. It may be a good example of diffusing toward understanding.
- What is magnetic helicity anyway? Why does it matter?
- The fact that the mean quasar spectrum closely resembles the sum of all photoionization models was striking; the selection effects for line strengths are so strong that a wide range of conditions always looks about the same. What do we have to do to dig out more fundamental truths? One example of examining details was a study of the time variability of the O VIII K-shell edge compared to the constant O VII absorption in a "warm absorber", in which it was concluded that warm absorbers are spatially extended multi-zone regions in which different parts are absorbing at different times.
- One participant noted that the development of ZEUS-MP is a nice example of how a community with common interests may gather around a project, expressing the hope that such gathering could become more common.

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- Where are the "collective" plasma effects in the interstellar medium hiding? Is it nature or we who are doing the hiding? (I'm not sure what this question is about, but maybe that just makes me one of the hiders.)

- The apparent need for heating of the warm ionized gas in the Galaxy beyond that available from photoionization stirred interest, the underlying assumption being that the ionization itself arises from photons. The distribution of the Hα emission shown from the Perseus Arm certainly gave the impression of concentration in large loops reminiscent of those on the solar surface. One participant wondered whether flare-like activity may have something to do with both the ionization and heating. Another contemplated the ionization advertised as being available from the X-ray emitting gas in the galaxy and whether in sum with the contribution from stars in the disk might lead to a net increase in photoelectric heating further from the plane—but the idea turned out to be inconsistent with the data that shows that the increased heating needed is correlated with density, not distance from the plane.

- Is there any evidence in the large number of Proplyds of the Orion Nebula for any evolutionary effects that might shed light on the star formation history of the region?

- Turbulence is beginning to seem important, for stirring, for enhancing transport, for the corresponding possibilities for enhancement of reconnection and thermal conduction, for the eventual dissipation and heating of the gas. How close are we to getting it right?

- Disks and Jets, Disks and Jets. Doesn't nature have any other ideas? What happened to spheres?

- In the core-halo observations of ultrcompact H II regions, aren't the core sizes showing us the actual size of the regions which form massive stars?

- When, exactly, did appealing to magnetic fields become respectable?

- Watch out for those resonance lines, they're often optically thick and for some geometries their ratios to other lines can fool you.

And, of course, I was personally appreciative of the wonderful presentations on:

- Ultraviolet and X-ray diagnostics of the solar corona,

- The high z structure of a galactic spiral density wave,

- Error estimates for X-ray emission lines in the hydrogen and helium isosequences,

- Dust and density distributions in H II regions,

- Photoionization of galactic gas by old supernova remnants, and

- Hydrodynamic simulations of supernova remnants in diffuse environments,

made by the six of my former graduate students who were at the meeting.

10. ENDING

The meeting closed after another round of applause for the organizers, whose genius had by this point had been revealed. Pepe asked me to express particular appreciation to Jane Arthur, and Nancy Brickhouse. All participants were aware of many of Jane's apparently tireless contributions, while Pepe found Nancy's help also invaluable in laying out parts of the scientific program.

Donald P. Cox: Department of Physics, University of Wisconsin-Madison, 1150 University Ave., Madison, WI 53706, USA (cox@wisp.physics.wisc.edu).

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