SOME CONCLUDING THOUGHTS FOR COOL STARS VI

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Lesser artists borrow, great artists steal.\(^2\)

Abstract In this Workshop summary I will highlight some of the major
trends in the field of cool stars research and call attention to some of the
important unanswered questions that I hope will become the scientific
highlights of the next Workshop.

INTRODUCTORY REMARKS

This, the sixth Cambridge Workshop on 'Cool Stars, Stellar Systems, and the
Sun', is now complete, except for a summary and much writing by the authors
and the Editor, our esteemed Chairman of the Scientific Organizing Committee,
George Wallerstein. Fortunately for all concerned, George gave me little notice
to prepare this summary. Thus my remarks will be mercifully brief but still
provocative. I will use this occasion to stimulate the reader with a voluptuous
cornucopia of \LaTeX\-mania with all the bounce of a neophyte.

I found this meeting replete with startling observations and scintillating
theoretical insights as is ordinary for these Workshops. After some general ob-
servations, I will list some of the scientific nonhighlights, those brilliant insights
conveniently postponed to the next Workshop. As is typical, some of the most
lasting results of the meeting are the devious plans for future collaborations
hatched at such temples of science as the Kingdome, Tilicum Village, Chateau
Ste. Michelle Winery, and of course, McMahon Hall. Before proceeding to the
science, let's record for posterity some of the more notable quotes of the meeting.

Most honest statement 'I want to talk about things that I know nothing
about.' (David Muchmore)

Most complimentary statement 'I wish to thank the Scientific Organizing
Committee for scheduling the Workshop during Sorority Rush Week.'
(David Gray)

Most transparent neologism 'Photon liberation movement.' (Dains Dravins)

Most unlikely statement 'I agree with you, Grant.' (Tom Ayres)

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\(^2\)This quotation from Igor Stravinsky was taken from \LaTeX\ A Document Preparation Sys-
tem, by Leslie Lamport
Most repeated statement 'Skumanich, HAO.' (Andy who?)

Three key accomplishments in the field are now indelibly recorded on my hard disk. One is Rutten's concise statement of Johansson's Conservation Law of Atomic Data, viz. the need for data x the funding level = constant. Prior to this meeting I had been ignorant of the term 'Poster Paper microtalk'. On Tuesday we heard oral descriptions of 45 posters in 60 minutes. Thus a 'PP μtalk' is an oral presentation of visual material in 80 seconds or less. The third innovation was 'Poster Paper microviewing' or 'PP μviewing' for short. On Tuesday we were allotted all of 30 minutes to view 45 posters. I calculate that the information content of posters was 42 Megabits and the required transmission rate was 20 kilobits per second. Surely this advance in conference-itis belongs in the Guiness Book of Records.

SOME OBSERVATIONS CONCERNING COOL STARS VI

The quality and broad nature of the papers presented at this meeting demonstrate that the field of cool stars research is very alive and well; it is rich in both data and theoretical ideas for their interpretation. I doubt if any one person at the meeting understood the ramifications of all that was presented.

Observers of cool stars now utilize most of the electromagnetic spectrum including the x-ray, ultraviolet, optical, infrared and radio regions. A number of authors are now intercomparing data sets obtained at different wavelengths, leading to panchromatic or multiwavelength perspectives. This trend will certainly continue. Imagine what the October 1991 Tucson meeting will be like with the much higher quality data anticipated from HST, ROSAT, ASTRO, and new ground-based facilities and instruments!

I am pleased that the field is not dividing into narrower subdisciplines. There is virtue to workshops on narrow topics of current interest, but this meeting demonstrates the virtue of broader meetings where crossfertilization and broadening of perspective can occur.

One measure of progress in the field is the development of more detailed evolutionary scenarios that place different types of data into context. I call attention to Sun Kwok's scenario for the evolution of AGB stars through the PN stage, and Steve Strom's picture of the aging process for T Tauri stars.

SCIENTIFIC HIGHLIGHTS POSTPONED TO COOL STARS VII

The various speakers clarified some of the major unanswered questions in the field that I hope will become the scientific highlights of the next Workshop.

- Peter Ulmschneider introduced a new critical number into stellar astrophysics, the Mach number for self-limiting shocks. If some chromospheres are indeed heated by self-limiting shocks, then the amount of acoustic wave heating does not depend directly on the details of the heating process, the effective temperature, gravity, or the mixing-length parameter α. The rate
of heating may depend only on the geometry and density structure of the chromosphere. Is this new approach valid? Also, fundamental constants are never simple numbers like 1.6, but are generally irrational. Perhaps the self-limiting shock strength is something like $\sqrt{2}$.

- Are any coronae heated purely by acoustic waves? In principle, such coronae can exist, but the x-ray luminosities $L_x$ are too low to have been observed to date. Perhaps ROSAT will answer this question.

- The nature of magnetic heating processes has become a very tangled question. Parker has placed the spaghetti model on the table, but it has not yet been digested. I found very interesting van Ballegooijen's estimate that anomalous resistivity must be $10^5$ times larger than classical resistivity to thermalize 50% of the nonpotential magnetic energy available in the corona. Is this possible? Does this explain how coronae are heated?

- Robert Rutten told us that one-dimensional modeling works well for explaining the disk-averaged solar photosphere. This troubles me for two reasons. First, when simple theory and observations agree, many people assume that the problem is solved and they go on to work on other problems. But we know that the photosphere is highly inhomogeneous, and it is the observed inhomogeneity that provides information on convection. Second, the apparent agreement between 1-D models and observations may be a result of the solar effective temperature being 5770 K, so that the peak of the Planck function lies near the visible. Thus the spatially-averaged flux from different structures with different temperature distributions is not greatly different from the flux from some mean temperature distribution. This benign situation cannot exist in much cooler stars where the Planck function peak lies in the infrared, and the weighting of the flux from different components is very nonlinear.

- Why are the 12$\mu$m Mg I lines in emission in the Sun, and will they be in emission in other types of stars? This question is important because these lines are very useful magnetic field strength diagnostics.

- Why does the chromospheric Mg II line flux appear to increase with age for the older stars as shown by Dupree? This appears to violate intuition and thus may be an interesting result if confirmed.

- Dainis Dravins predicted that at $\tau = 1$, the temperature contrast of granulation should increase with stellar luminosity (at constant $T_{\text{eff}}$) and towards cooler stars along the main sequence. I look forward to a critical test of this clear prediction.

- How do chromospheric and coronal activity depend functionally on stellar age? This question has been with us for at least 30 years. It now appears that the venerable $\sqrt{t}$ law is not valid and various $e^{(-ct)}$ laws fit the data better, but other parameters may also be important.
Concluding Thoughts

- As Lee Hartmann has convincingly argued, the ‘stellar activity model’ has been superceded by accretion disk/boundary layer models for explaining the energy budget of pre-main sequence stars. What remains to be understood is how these new models work in detail, especially when magnetic fields and bipolar flows must be included.

- Steve Strom also provided evidence that solar systems do form. This was pleasing. Perhaps next time he will tell us how.

- Sun Kwok provided us with a paradigm for understanding the evolution of AGB stars that cannot be seen. We shall see or not see.

- David Muchmore reminded us that to compute the properties of stellar winds one should take into account: thermal instabilities (both local and global), polymerization, molecular dissociative disequilibrium, condensation nonequilibria, photodissociation, and dynamics. He never once mentioned the word critical point. I suggest that we need to find out what effects may be safely ignored in order to make any progress in this topic.

- Roberta Humphreys broadened our horizons by discussing the most luminous cool stars, the red supergiants. I look forward to learning more about how these stars trace the evolution of massive hot stars.

- Larry Ramsey asked but could not answer the question, What is a plage and what is a flare?. He did show us beautiful FOE data that indicate mass transfer and continuous low level flaring in RS CVn systems. Perhaps these data will be explained during Cool Stars VI.

- There are many additional comments that could be made concerning the invited talks, and I have not even mentioned the many excellent posters.

A FINAL THOUGHT

In the Preface to the Proceedings of the Fifth Workshop, I planted a land mine to test whether anyone reads prefaces. The mine never exploded, since I received no requests to translate the Latin salute Fatigatis nihil otium to the hapless and naive organizers of this meeting. So, for all of you who have been waiting two years but never asked, I will translate the expression as ‘There is no rest for the weary’. The hapless and naive organizers of the next meeting, Mark Giampapa and his not yet selected co-conspirators, should never have it so good.

I acknowledge the support of the cool stars research at JILA by several NASA grants, including Grant S-92522-D to NIST and NAG5-82 to the University of Colorado. I thank Dr. Robert Stencil for his comments and Dr. Wallerstein for his patience and tolerance.