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# Theory and Modeling Group

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The primary purpose of the Theory and Modeling Group meeting was to determine who is doing (or is interested in doing) theoretical work pertinent to the MAX '91 Program, and to encourage theorists to pursue modeling which is directly relevant to data which can be expected to result from the Program. The number of scientists participating in the Group ranged from ~ 25–30. The morning 1.5 hours of the Group meeting was devoted to determining the research interests of those present at the meeting. Each participant briefly summarized the research he or she is doing relevant to active regions and flares. The afternoon (2 hours) was devoted to open discussion of several topics pertinent to the science as well as the organization of the MAX '91 Program. The discussion was sometimes rambling, but generally lively.

A list of participants and their institutions is contained in the table on the following page. The table is organized by subject areas in which the participants expressed interest, so a few are listed more than once. Since the catagorization was determined on the basis of interests expressed at the meeting, it does not necessarily represent the full range of interests of each scientist. Likewise, since the categories are somewhat broad, the table does not reflect the specific research interests of each participant. This information can be found in the contributions from the individual scientists that follow this summary. The catagorization does provide, however, an overview of the range of subject areas represented at the meeting.

In contrast to the strong attendance at the Theory Group meeting, only 5 theoretical papers had been submitted to the MAX '91 Workshop: 2 from Goddard (S. Benka and G. Holman), 2 from Colorado (M. McKean and R. Winglee), and one from Stanford (J. Klimchuck). Much of the afternoon discussion was concerned with the existence and formation of multiple current channels and their return currents in flaring regions, since this was a common theme in the papers from Colorado and from Goddard, as well as other papers presented at the SPD meeting. There is clearly increasing interest in how these current channels might be formed, and the observational consequences of their presence. This will be an important issue in the interpretation of MAX '91 data.

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| **Magnetic Field Strength, Structure, and Evolution** | |
| *G. Holman* | NASA/Goddard |
| *J. Klimchuck* | Stanford U. |
| *Z. Mikic* | SAI, San Diego |
| **Reconnection Theory** | |
| *P. Liewer* | JPL |
| **Electron Energization** | |
| *S. Benka* | U. North Carolina & NASA/Goddard |
| *G. Holman* | NASA/Goddard |
| *G. Roumeliotis* | U. Alabama, Huntsville |
| **Electron Beam, Return Current Properties** | |
| *G. Emslie* | U. Alabama, Huntsville |
| *M. Karlicky* | Astronomical Inst., Prague |
| *M. McKean* | U. Colorado |
| *P. McNeice* | STX, at NASA/Goddard |
| *D. Spicer* | NASA/Goddard |
| *R. Winglee* | U. Colorado |
| **Electron Trapping and Escape** | |
| *R. Hamilton* | Stanford U. |
| *E. Lu* | Stanford U. |
| **Ion Acceleration and Beam Properties** | |
| *P. Cargill* | U. Maryland |
| *F. Lang* | Catholic U., at NASA/Goddard |
| *M. McKean* | U. Colorado |
| *C. Werntz* | Catholic U., at NASA/Goddard |
| *R. Winglee* | U. Colorado |
| **Chromospheric Evaporation** | |
| *G. Emslie* | U. Alabama, Huntsville |
| *R. Falciani* | Inst. di Astronomia, Florence |
| *D. Zarro* | ARC, at NASA/Goddard |
| **White Light Emission** | |
| *G. Fisher* | U. Hawaii |
| **Soft X-ray Observations** | |
| *D. Batchelor* | NASA/Goddard |
| *J. Saba* | Lockheed, at NASA/Goddard |
| *K. Strong* | Lockheed, Palo Alto |
| **Radio Observations** | |
| *N. Gopalswamy* | U. Maryland |
| *E. Schmahl* | U. Maryland |
| *G. Thejappa* | U. Maryland |
| *S. White* | U. Maryland |
| **Laboratory Experiments** | |
| *T. Tamano* | General Atomics, San Diego |

A couple of solar flare paradigms were discussed, with neither of them receiving any strong support from those present. One of these was the importance of magnetic reconnection in flares. Although it is generally agreed that magnetic reconnection plays a role in flares, it is not apparent that magnetic reconnection need be the primary mode of energy release in flares. Magnetic reconnection is often taken as a starting point for flare models, but no arguments were found for why this need be the case. It is also often stated that the primary release of flare energy occurs at the top of coronal loops. Although observational evidence from the last solar maximum seemed to indicate this, it is now apparent that this need not be the case.

Another topic of discussion was the applicability of numerical simulation results to solar flares. Clearly, the results of a numerical simulation are only as good as the physical processes and conditions that can be (or have been) included in the code. For those not directly involved in the simulation, this is often difficult to judge. The detailed discussion and comparison of numerical simulations may be an appropriate topic for a group meeting at a future MAX '91 Workshop.

Given the observations planned for this solar maximum, in what areas might significant progress in our understanding of the physics of solar flares be expected? Improved imaging and spectral information in soft X-rays and microwaves and the availability of vector magnetograph observations should yield much better information about pre- and post-flare active region structures, magnetic field strengths, and plasma properties. Improved X-ray and microwave observations should lead to significant progress in determining the balance between heating and electron acceleration in flares, and to tighter constraints on the properties of the acceleration region. More detailed information about the evolution of plasma heated during flares should become available. A better understanding of the importance and properties of microflares should also become available. Gamma-ray observations should lead to more detailed information about the spatial, directional, and spectral distribution of the energetic electrons and ions responsible for this emission, and about ion abundances in the solar atmosphere. All of these areas are ripe for further theoretical work.

On the other hand, it is not likely that significant information will be obtained relevant to the role and properties of magnetic reconnection in flares. (In the upper atmosphere, at least, where the magnetic pressure is dominant. Improved optical observations may provide some information about this at photospheric and chromospheric levels.) Likewise, there is not likely to be any conclusive information about the possible role played by energetic protons in flares, except for the high-energy particles involved in the production of nuclear $\gamma$-ray emission.

The impression left from this Workshop is that it would not be productive to have any further Theory and Modeling Group meetings. Rather, it would be better to have a variety of topical sessions promoting interaction among theorists and observers. It would, however, be useful to have occasional special working groups on specific theoretical topics relevant to the MAX '91 program. These groups would have to be well-planned and small enough to make significant progress. Topics for these working groups might include the theoretical extrapolation of vector magnetic field measurements, comparison of electron beam/return current simulations, or modeling of chromospheric evaporation. Also, a number of investigators in both Europe and the U.S. have recently been working on the magnetic trapping, scattering, and precipitation of particles in flares. It would undoubtedly be worthwhile for these researchers to compare their methods and results. These special working groups should not interfere with the need for theorists and observers to interact, however, as is required for a strong, healthy scientific program.