

INTRODUCTION

1. Arrangements

The Sixth Symposium on Cosmical Gas Dynamics, the fourth in the series to deal with gas dynamics of the interstellar medium but the first on that subject since 1957, was held near Yalta, the Crimea, U.S.S.R., at the Sanatorium PARUS, from 8–18 September, 1969, under the joint sponsorship of the IAU and the IUTAM. The host was the Crimean Astrophysical Observatory, whose Director is Professor A. B. Severnyi. It was most fitting that the first meeting of the Cosmical Gas Dynamics series in the U.S.S.R. was held very near this observatory, which, under the directorship of the late Professor Shajn, became an outstanding center in the field of interstellar gas dynamics.

Approximately 140 scientists attended all or part of the sessions. Of these, 23 were from the U.S.A. and Canada, 26 from Europe outside the U.S.S.R., 1 from Australia, and 96 (among them 15 young auditors) from the U.S.S.R. Participants were housed in local sanatoria; thus the living aspects were those of a vacation resort, while the participants could attend the formal and informal sessions without loss of time.

In addition to the IAU-IUTAM support, financial and organizational aid came from the U.S.S.R. Academy of Sciences, the Crimean Astrophysical Observatory, the Yalta Town Soviet, the Joint Institute for Laboratory Astrophysics in Boulder, Colorado, and the Office of Scientific Research of the U.S. Air Force. In each case, support was in the form of a grant or organizational help, given without restrictions for the planning and mechanics of the Symposium.

The chairmen of the scientific organizing committee were Dr. A. B. Severnyi (for the IAU) and Dr. L. I. Sedov (for the IUTAM); members were Drs. S. B. Pikel'ner, F. D. Kahn, J.-P. Zahn, and R. N. Thomas (for the IAU) and Drs. H. F. Clauser, J. M. Giraud, and M. J. Lighthill (for the IUTAM). Drs. A. A. Boyarchuk and R. E. Gershberg were in charge of the local scientific arrangements. Dr. P. P. Dobronravin and Mr. E. Nikolaev, Assistant Directors of the Crimean Astrophysical Observatory, had overall direction of the Symposium arrangements. They were assisted by Mr. O. Blinov, Mr. A. Pilyugin, and others of the technical staff of the Observatory. Overall, the scientific and general program planning were handled efficiently and graciously by Drs. A. B. Severnyi and S. B. Pikel'ner. All participants will long remember their hospitality and scientific organizational ability. English was the only official language during the Symposium. We, the writers of this introduction, know that we speak on behalf of all participants from outside the U.S.S.R. when we express our gratitude to all our hosts for sponsoring so enthusiastically a Symposium in a language different from their own.

As at the previous two Symposia in the series, each problem chosen was introduced by a summary speaker with a long discussion following. All discussions were recorded, the tapes transcribed verbatim, and the transcriptions given to the participants for on-the-spot editing. We were successful in transcribing and distributing records of all sessions during the meeting, save those of the last day. This success is due to the organizational talents of Mrs. Robert J. Low, to the help of Dr. Katharine Gebbie, Dr. Beverly Lynds, and Miss Bess Alta Thomas, and to the efforts of Dr. Severnyi's staff.

The participants voted to dedicate the volume of the proceedings to Professor J. H. Oort on the occasion of his 70th birthday and his retirement as Director of the Leiden Observatory, in grateful appreciation of his work with Professor J. M. Burgers in starting and maintaining this series of Symposia.

2. Scientific Program

The impetus to this series of Symposia came from the proposal by Burgers and Oort that the interstellar medium be treated as an aerodynamical continuum, in which the interstellar clouds would appear as velocity fluctuations in a generalized turbulence. Earlier the clouds had been pictured as essentially discrete individual entities. The first three Symposia in the series considered detailed questions arising from this suggestion; for example: what instability – or instabilities – might produce such clouds?; what kind of a turbulence description might be suitable?; how must we incorporate the large density fluctuations associated with the velocity fluctuations into an aerodynamical turbulence picture? The earlier Symposia are largely characterized by the fact that answers suggested at one Symposium were negated in succeeding ones. Two examples: first, the suggestion, and apparent observational verification, of a Kolmogoroff-type turbulence was later rejected because of better observations and the difficulty of incorporating the associated large density fluctuations. Second, there was the suggestion that differential galactic rotation would drive the clouds. However, later suggestions implied acceleration of interstellar material by hot stars, an entirely different kind of mechanism in which the motions of the clouds seem to be only random, because of the apparent (semi-) random distribution of the hot stars, not because of turbulence in the more common aerodynamical sense. On the other hand, Zanstra's suggestion during the 2nd Symposium of a two-phase equation of state for those astronomical phenomena where the radiation field plays a significant role, the early arguments for the importance of plasma-hyromagnetic effects, and the suggestions of the existence and importance of collisionless shocks seem to have persisted. Apparently we were in the situation where certain physical effects looked important, but where we did not know how to use these effects to explain or systematize the array of astronomical observations. In planning the present Symposium it was hoped that the first part would bring into focus these considerations from the earlier Symposia, assess their present status, and place in perspective possible future work. The wealth of problems to be solved presents a great challenge.

The second part of the Symposium concentrated on mass interchange between stars and interstellar medium. This subject gives some continuity with the last two Symposia on aerodynamical phenomena in stellar atmospheres. In the present Symposium, as in the first ones in the series, interest lay in the amount, and the consequences, of such mass flow on the state of the interstellar medium. A third aspect of the Symposium concentrated on the formation of stars, on interstellar grains, and on interstellar molecules. The table of contents gives the planned program.

3. Some Remarks in Evaluation of the Symposium

1. PARTICIPATION

The original aim of Burgers and Oort had been to start a discussion between dynamicists and astronomers so that the astronomical problems might be clarified in an aerodynamical context. The emphasis in these Symposia lies, then, not on solving any problems during the Symposia, but on defining what the problems are and making some suggestions for future investigations. Already in 1948 it became clear that plasma physicists, as much as aerodynamicists, would be valuable participants.

In a narrow sense, the Symposium was not very successful in attracting a balanced representation of aerodynamicists. Most of the aerodynamicists were new; we lacked people who had attended earlier Symposia, and were reasonably familiar with the astronomical 'language'. As a result there was not as strong an interchange between aerodynamicists and astronomers as at previous Symposia. On the other hand, Severnyi, Pikel'ner, and Sedov had an extraordinary success in attracting a large number of young astronomers and plasma physicists who were very eager to apply their experience to a variety of astronomical problems. In a broader sense the Symposium was very successful in bringing into fruitful contact those groups with a common interest in interstellar gas dynamics, but not always very extensive contact possibilities. These groups are indicated by the contrasts East-West and young-old. Most participants appeared to be enthusiastic about the discussions, formal and informal, and many participants felt stimulated to continue working in the area of cosmic gas dynamics. The fruitfulness of these contacts was made possible, in our view, by the schedule of the Conference, which called for (and achieved) some three hours of free discussion (no reading of papers) per invited summary Report.

This brings us to the following conclusions. (i) Further discussion between aerodynamicists (or even magnetohydrodynamicists), plasma physicists, and astrophysicists remains a very desirable goal (for convincing evidence see the remarks by Goldsworthy, p. 94). However, the discussion needs stimulation. At one point at this Symposium it was noted that aerodynamicists need information on individual objects – but that astronomers usually provide only general averages, which tell very little about the aerodynamical model to be adopted. Since the observational techniques are rapidly improving in quality and increasing in variety, Goldsworthy's suggestion is to be kept in mind. It might be worthwhile to submit for publication summaries of high quality observations and tentative interpretations on individual objects in such

journals as *Physics of Fluids* and the like. In the second place the IUTAM member of the organizing committee of a future Symposium in this series should make an effort to bring in aerodynamicists who already have some background in the subject and can help trigger the discussion. They should be invited to give an introductory report. (ii). The schedule of this Symposium seems very satisfactory to many participants. It appears to us that the policy of suppressing the reading of short communications is a very healthy one. From the present Symposium it is evident that fruitful discussions can take place, even in a group of 100 to 150 persons. (iii) Younger astronomers certainly have a need to attend meetings like this where it is possible to meet senior people. It seems very desirable to organize in various countries similar working symposia, composed of perhaps 20 to 25 percent active workers from abroad, the rest, people from within the country who, for one reason or another, have not had much chance for participation in such symposia outside their country. Emphasis would be on cross-discipline subjects; naturally, we are prejudiced towards astronomy as the central theme, with its boundaries defining the border fields. Informal East-West contacts should be stimulated, improved, and extended.

2. SCIENTIFIC CONTENT

Of course, any evaluation and impression is highly personal. To us the first and main part of the Symposium is characterized by noting that both theory and observation presented new and very fundamental material, but that we do not yet know how to interpret, understand, and use it. In the observational approach we are rapidly coming to the point where the whole sky will have been observed in the 21-cm line with a beamwidth of 0.6° . This set of data may be compared with the Palomar Sky Atlas; although there are only 100 independent data points per field of the dimension of one sky survey plate, a third dimension (radial velocity) has been added. The material reminds one of the phenomenological investigations in the early studies of laboratory turbulence and may well provide us with the same solid basis for a discussion, although the interpretation is considerably more complicated than in the laboratory. One has to unscramble excitation, composition, and radiative transfer effects to get a geometrical picture. Obviously, 21-cm line observations with larger angular resolution will show new phenomena, as Verschuur emphasized several times; but there is reason to believe that much phenomenological insight on the larger scale structures (20 to 100 pc) can be obtained from the data already available. On the theoretical side at least three fundamental effects have been discussed in recent years. Two of them are the thermal instability leading to a two-phase system (the concept has a history back to Spitzer at the first Cosmical Gas Dynamic Symposium and to Zanstra at the second), and a variant of the Rayleigh-Taylor instability, discussed by Parker. Both effects are thought to be extremely fundamental, but both have been studied only in linear approaches and one has sought for static solutions, whereas certainly the theory has to be nonlinear and one should look for dynamical equilibria. Therefore a clear assessment of the value of these two concepts is not yet obtained. The third theoretical achievement of recent years is the spiral-wave theory. It was

definitely under-discussed at this meeting, due to the fact that a preceding Symposium (IAU No. 38) was dedicated to spiral structure. Also, in this case there is room for much clarification of the basic concepts of the theory. During one of the informal, unrecorded meetings, Pikel'ner attempted to give a synthesis of the way these three mechanisms might interact (see Field's summary at p. 102). Although the picture given is extremely tentative it implies many suggestions for future research – both theoretical and observational (see the Final Discussion, p. 362). If the picture is correct it is remarkably similar to that discussed at the first Symposium: The interstellar motions represent a sort of 'turbulence' triggered ultimately by the differential rotation of the Galaxy. In this sense the present Symposium is a true child of the previous ones.

The Introductory Reports on mass-ejection, in either the quasistatic situations or the not-so-static situations, emphasized the rudimentary state of our knowledge. The observational material has increased many-fold; the big problem is how we interpret these observations. Even among the theoreticians, there was a tendency to confuse mass-loss possibly associated with a stellar wind with a mass-loss visualized in the earlier models, not based on such an underlying physical picture. The problem is tied to the general aerodynamical phenomena in stellar atmospheres so that the two kinds of Symposia held thus far in the series overlap.

At the present Symposium the discussions of physical background revolved around plasma turbulence and hydromagnetic problems; the Reports were excellent and most stimulating. However, one also had the feeling that attempts to make hydro-magnetic models were stretched quite a bit – that one had a technique looking for an application rather than a great deal of insight into the astronomical problem and the boundary conditions to be satisfied. But overall, one was impressed by the number of people working in various aspects of plasma physics and trying very hard to apply their knowledge to astrophysics, to really clarify the problems there. Again, this effort promises interesting future developments.

In summary, it is our impression that this Sixth Cosmical Gas Dynamics Symposium was both timely and useful. Recent developments were discussed, both theoretical and observational, which may prove to be fundamental breakthroughs. A new group was formed willing to continue to explore these breakthroughs. All in all, cosmical gas dynamics, in the words of Busemann, remains a domain where one is "not hindered by too much information, but has to rely on best guesses, and where one can return to a state of innocence, proper for a scientist".

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