Hayashi: The summary by Professor Tayler is so complete and clear that there is almost nothing left for me to talk about. Perhaps I will say something about my impression of the Symposium. Study of stellar evolution began about thirty to forty years ago. In those days the problems were rather simple but nowadays they are so complex. However, computers have made great progress possible. But for them, the progress in the stellar evolution theory would have been very little. This is because nature is fond of complexities and diversities. With the aid of computers we have reached a very detailed understanding of the structure and evolution of the stars.

Although there are many differences and disputes in computational results, I am not worried about them because time will shortly solve them. In the IAU General Assembly 1961, Professor M. Schwarzschild gave an invited discourse. He divided stellar evolution into three phases: almost-hydrostatic, slowly contracting, and dynamical phases. He stressed the importance of the dynamical phases. Also in this Symposium, most of the fundamental problems other than elementary processes lie in the dynamical phase including magnetohydrodynamics, turbulence and convection. They have more degrees of freedom than those lying in stellar models. In the near future, I hope, much more progress will be made in hydrodynamic problems. In this Symposium it is the "problems" which are presented. When the problems are presented clearly, then the solution is not so far from being realized.

Nevertheless, I would offer a remark on computational work. Though sometimes the computer discovers new facts, the most important task is to construct a "theory" from the computational results. In the old days, I used computers somewhat by myself. These days I do not use them by myself, but rather I try to construct theory. I think it is a role to be played by an older generation because I started my career without computers. Before closing my talk on my impression of the Symposium, I would say once more that I, as a member of an older generation, like simplicity even though nature is fond of complexities.

Hayakawa (Chairman): Is there any comment, particularly from the younger generation who has grown up with computers?

Sugimoto: Of course both computational and theoretical works are equally important. In many cases simple interpolation formulae are usually confused with theories. The latter should explore the reasons why such numerical relations result. In developing theories, numerical results are very helpful. However, they are helpful only when important quantities are properly described in papers. In order to know what are the important quantities, a theory is required. Recently many numerical

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results have been published, but very often, however, they can be used only for constructing interpolation formulae but not for constructing theory.

Tayler: When I was calculating stellar evolution on a desk calculator, I calculated the evolution of massive stars away from the main sequence. I considered the possibility of evolving low mass stars without convective cores but estimated that it would take six hours a day, five days a week for twenty months. I did not do it.

Miyaji: Perhaps the chairman nominated me because I have just finished my doctoral thesis and during the last two years I have been one of the top users of the computer at the Tokyo Astronomical Observatory. In my computations of electron-capture supernovae, convection due to entropy production by electron capture plays an essential role. Before my computation, such a possibility had not been pointed out, and of course I neglected it at first. Thus I had to spend another year in order to take such convection into account. From my limited experience above, I would like to agree with the comments from theorists of the older generation that the physics is sometimes recognized only after the computations.

Mouschovias: Concerning the effect of mass loss on stellar evolution, it may be important to remember that there are a large number of results available about our own solar wind, from which we should benefit. Skylab has shown that the solar wind (1) may originate mostly from coronal holes (which have open magnetic field lines); (2) may not exist as a quiescent wind; and (3) coronal transient events seem to contribute significantly to the mass in the solar wind. It is hoped that the Solar Maximum Mission, now in progress, will give definitive answers to these issues. In any case, in introducing mass loss into stellar evolution calculations, it is important to draw from the knowledge of our own sun.

Van den Heuvel: An important question, that is especially relevant to the X-ray binaries and bursters, is whether neutron star magnetic fields decay or not. Could anyone tell what the present status of the thinking about this problem is?

Lamb: Observations of pulsars suggest that they turn off after about 10^7 years (Manchester and Taylor 1977). This has frequently been taken as evidence that neutron star magnetic fields decay on such a time scale. Indeed, Flowers and Ruderman (1976) have shown that any magnetic field arising from currents in the crust may decay on such a time scale due to ohmic dissipation. However, Baym, Pethick, and Pines (1969) have shown that any magnetic field arising from currents in the core of the neutron star will decay on a time scale that is longer than the present age of the universe because the conductivity there is so high. Flowers and Ruderman therefore proposed that an instability may lead to fluid motions which cancel out the magnetic field, much as one can do so by flipping over one of two bar magnets. However, this model is a very simple one, and it is not known whether it has any relevance to the real physical situation in the cores of neutron stars. In fact, there are many other alternative ways in which pulsars may turn off. For example, the magnetic and rotation axes may align due to the radiation torque. Finally, recent observations of X-ray (Oda et al. 1980) and gamma-ray (Mazets et al. 1980) bursts indicate the presence of strong magnetic fields. In particular, the gamma-ray burst spectra appear to show cyclotron absorption or emission features. If the burst sources do, in fact, involve very old neutron stars, these observations may indicate that neutron star magnetic fields do not decay.

Van den Heuvel: There have recently been rumours that the neutrino might have a rest mass. Is there anyone who could comment on the effects which this might have for the solar neutrino problem?

Sato: I am not a specialist in the solar neutrino problem. On the basis of the measurement of neutrino flux, it is said that the electron neutrino may be oscillating among other types of neutrinos, for example the tau neutrino. The solar neutrino flux would then be decreased to half of that previously estimated. If neutrinos oscillate among three states of neutrinos, it will be decreased by a factor of three. This, I think, is the main effect of massive neutrinos on the solar neutrino problem. I think its more important effects in astrophysics are expected in the problems of "missing mass" in galactic halos, binary galaxies, rich cluster of galaxies and so on. They might be explained in terms of the rest mass of neutrinos.

Salpeter: I want to emphasize the point that has just been made that, even if there are massive neutrinos and neutrino oscillations, the flux of Reines' experiment is at most decreased by a factor of three. So it is not at all clear that even if there are massive neutrinos the astrophysicists can go home. There might still be a solar neutrino problem.

Salpeter: What would be the role of neutrino oscillations in stellar collapse?

Mazurek: If the oscillations occur on a time scale that is long compared to that of stellar collapse, they probably would not affect things too drastically. However, if oscillations occur on a much shorter time scale, the efficiency of neutrino trapping could be decreased appreciably. It is true that the Rines' results indicate a much shorter time scale for the oscillations. In this sense, we may have to worry about their effects. However, in dense matter the amplitude of such oscillations will be strongly suppressed. Thus it is not clear at present what the effects on stellar collapse will be. At present the most pertinent point, however, is that we do not know the detailed properties of neutrino oscillations, if they occur. Until we do, their effects on stellar collapse can only be conjectured.

Massevitch: Concerning the structure of the sun, another problem facing modern theory is the recently discovered solar oscillations with a period $2^h\ 40^{min}$. This result, which was obtained several years ago at the Crimean Observatory (USSR) by Prof. Severny and his collaborators, contradicts the generally adopted model of the sun (and its oscillation modes). Several attempts have been made to change the solar model in a way that would make such a large period possible. There have also been many doubts expressed about the reliability of the observational deta.

Recent observations carried out in the USA and UK have confirmed the period originally obtained and it is now up to theorists to provide its interpretation.

Osaki: I am sorry that I cannot say anything important concerning the $2^h\ 40^{min}$ solar oscillation. However, it is very difficult to explain because the fundamental period of the sun is about an hour. In order to explain a period of this length, we must consider a high order gravity mode. Even if this were the case, another difficult question arises, namely, how and why is such a high order gravity mode excited and why is a single mode selected from the dense spectrum of high order g-modes.