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Prof. Philip R. Goode
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Dear Phil,

I came to know you are going to propose replacement of the BBSO principal telescope of 65cm aperture with a modern 1.6m aperture instrument. I am writhing you to support your proposal, and I would be happy if this letter could be helpful even slightly for your proposal.

Needless to say, the Sun is irreplaceable for the terrestrial environment and life on the earth. Understanding the physics of the Sun is closely related to our daily life, hence the Sun has been intensively investigated from the early stage of modern astronomy and astrophysics. There still remain, however, many issues in solar physics. Let me list up some of them:

- The surface MHD phenomena; the energy release mechanism: Though sunspots have been known since the ancient times, their physics is still unveiled. Flares are the most prominent surface phenomenon. But the energy build-up and release mechanisms have not yet been established.
- The cause for the solar activity: The 11-year solar activity cycle is well known. The solar dynamo theory which has been developed to explain this activity is based upon the nonlinear interaction between convection and rotation. Are the assumed rotation and convection features confirmed? It is now known that the solar luminosity varies with the solar activity. This implies variation in convective energy transport. How and where is energy stored in the convective envelope?
- The cause of the surface latitudinal differential rotation: The surface rotation rate decreases with increasing latitude. Why? How is the gas streaming three-dimensionally with rotation?

- **Physics of convection:** Convection is one of the fundamental processes for which theoretical description is still unsatisfactory. In the solar case, various scales of convection motion, such as granulation, supergranulation, meso-scale convection, and giant cell convection, should be theoretically described.
- **The physical cause for the existence of corona and chromosphere:** Why does the temperature inversion occur in the chromosphere and how is the very high temperature corona maintained? Structure of the chromosphere and the corona should be clarified.
- **The internal angular momentum distribution:** Only the surface rotation rate has been measurable for the Sun and stars. Rotation must have some effect on the evolution of the Sun and stars, but this has so far been unmeasurable. How is the solar interior rotating?
- **Evolution of the solar internal rotation:** The core of the Sun shrinks with the evolution of the Sun. If the angular momentum is assumed to be conserved in each gas element, the core is expected to increase in rotate rate rapidly with evolution. Is this true? If yes, how rapidly is the core spinning? On the other hand, the surface layers are expected to spin down by angular momentum loss due to the solar wind. Is this true?
- **The Li depletion problem:** The surface lithium abundance is less than expected from other chemical element abundances. Since the temperature in the convection zone is too low for lithium to burn, this implies that lithium has been carried into the deeper zone by some unknown mechanism.
- **Instability during evolution:** It has been shown that the Sun becomes vibrationally unstable to gravity modes excited by epsilon-mechanism of ^3He . Does this instability nonlinearly develop so that it affects later evolution of the Sun?
- **The neutrino problem:** The solar neutrino fluxes actually detected on the earth are much less than the theoretically expected amounts. This disagreement is now explained by transformation of the electron-neutrinos generated in the solar core to other kinds of neutrinos. The physical cause of this neutrino oscillation is the non-zero mass of neutrinos, and determination of the mass of neutrinos is highly desirable. Its impact is strong in particle physics as well as in other fields of astrophysics, such as cosmology.

Studying these issues is worth doing, not only for the understanding of the Sun, but also for establishing the physics of stars which are the fundamental constituents of the universe. Big Bear Solar Observatory (BBSO) has contributed very much to various aspects of solar physics. In particular, its contributions to the recent progress of helioseismology are conspicuous, and the present great success of helioseismology would not have been available without BBSO. New Jersey Institute of Technology, in collaboration with the University of Hawaii, is proposing to upgrade BBSO by replacing its principal telescope of aperture 65cm with a modern 1.6m aperture instrument. The new telescope will offer a significant improvement in observational capabilities and will be definitely useful to enhance investigations of the issues mentioned above. The combination of the new powerful

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instrument set at the good observation site, BBSO, and an excellent science team led by you and Jeff, the PI and Co-PI, will contribute further to our understanding of the Sun and stars, and eventually of the universe. International collaborations with many space projects, such as Solar-B, are also expected, and the benefits of the BBSO new telescope are immeasurable from this point of view. I never hesitate to support strongly your proposal of the 1.6m new solar telescope at BBSO.

Sincerely yours,



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