

Suggestion: Each person should pick three topics and email those to me. In that way, if more than one person is interested in a given subject, there will be alternatives.

The assignment is to identify at least three readable references (I will try to help) on the subject that is assigned to you, read those references, and make a presentation to the class in the style of a conference talk.

Feel free to suggest your own talk – but not something connected with your research.

Topics:

1. Describe the nuclear physics technique by which the solar neutrino cross section for ^{37}Cl was determined. Discuss the analogous work for ^{40}Ar (relevant to the proposed ICARUS liquid argon detector).
2. Describe techniques that are used to deduce the abundances of metals in the surface of the sun from solar absorption lines. Discuss the recent results of Asplund et al. and their implications for solar neutrinos.
3. Describe ideas for explaining the abundance of Li/Be/B, including cosmic ray, neutrino, and other nucleosynthesis. Describe what is known about the abundances of these elements in the cosmic rays.
4. Describe recent work on the elemental abundances in globular clusters and in metal deficient stars in our galaxy. What patterns have emerged?
5. Describe models for the neutron sources needed for the r-process, including the astrophysical sites, likely duration, and intensity.
6. Describe how helioseismology measurements are made, including the instruments used, the data collected, and the analysis performed.
7. Describe the basic theory of helioseismology. What is the connection to the sound velocity? What kinds of oscillations probe the convective zone and the solar interior, respectively.
8. Describe the kinds of techniques that are used in large underground water detectors, such as Kamiokande, to eliminate low-energy, muon-induced backgrounds that might interfere with solar neutrino measurements.
9. Describe ideas for measuring the pp and CNO neutrinos, including proposed detectors like SNOplus, CLEAN, and HERON.
10. Describe the status of measurements constraining the third neutrino mixing angle θ_{13} , including future experiments like Double Chooz and Daya Bay.

11. Describe long-baseline neutrino oscillations to determine the neutrino hierarchy or to see CP violation. Describe the ideas behind off-axis and broad-band beams.
12. Discuss suggested sites for the r-process, including differences (frequency, amount of ejecta per event) among these sites.
13. Tell us about gamma rays from long-lived Al and Ti and how measurements of these gamma rays might be useful in probing past galactic supernovae, etc. What instruments are used to measure nuclear gamma rays?
14. Tell us about various estimates of the galactic supernova rate, including pulsar counts, optical counts, nucleosynthetic output, etc. What are the uncertainties? Is the galactic supernova rate constant?
15. What are the techniques for measuring the highest energy cosmic rays? Describe the Pierre Auger observatory and the methods it uses to determine the energies of very-high-energy events.
16. Describe the basics of Type Ia supernovae: the explosion mechanism, their frequency, connections between peak brightness and duration, their use as standard candles, and the conclusion on dark energy/matter derived from Ia observations.
17. Describe possible hiding places for dark baryons. Discuss the MACHO searches and what has been learned from these searches.
18. Describe the morphology of gamma ray bursts. Discuss any associations with supernovae. Describe their origin – local or cosmological.
19. Describe what is known observationally about the long-term cooling of neutron stars, including the compatibility of observations with theory.
20. Discuss experimental techniques that have been used for measuring reactions like ${}^7\text{Be}(p,\gamma)$ and ${}^{14}\text{N}(p,\gamma)$.
21. Describe the light curves of Type II supernovae and the expected power sources for that light curve.
22. Describe the basic physics of underground laboratories: how are penetrating muons produced, what happens to their spectrum and flux as they propagate through the earth, what measurements exist that can be used to calibrate simulations, what is the difference between a “mountain” site like Gran Sasso and a flat site like Homestake, what absolute limits to backgrounds exist underground.