Aspen Center for Physics Proposal for Summer 2007: 
Supernovae as Cosmological Distance Indicators

• Organizers:
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• Preferred Weeks:
  We would prefer a two-week workshop. Due to schedules of the organizers and several likely
  participants, preferred dates are June 17-30, Aug. 5-18, or Aug. 12-25. Overlap with the
  proposed workshop on GRBs would be beneficial to both, especially given the growing interest
  in using GRBs as distance indicators, but is not required.

• Description and Justification:
  The use of supernovae as cosmic distance indicators has undergone tremendous expansion
  since the discovery of the accelerating Universe by two teams in 1998. Major supernova sur-
  veys (e.g., ESSENCE, SNLS, SNF, CSP, KAIT, CfA, and SDSS, among others) are currently
  underway, while even more ambitious projects aimed at probing the nature of the dark energy
  are planned (e.g., PanSTARRS, DES, Sky Mapper, LSST, JDEM, etc). Several of the on-
  going surveys will be coming out with first cosmological results between the submission of this
  proposal and the time of the workshop, so a workshop in summer 2007 to digest and critically
discuss these results will be optimally timed. We will bring together key participants in SN
observations to present their results and mutually critique each others’. The workshop will
also foster dialogue between the observers and SN theorists who are using the observations to
test and refine models of SN explosions and observables. Theory participants will overview
the current status of supernova modeling and the prospects for improving it, with the aim of
addressing how SN theory can or should feed into SN cosmology. The workshop will also aim
to give cosmology theorists (who use SN data to constrain cosmological models) a healthy
appreciation for the subtleties and challenges involved in producing SN distance estimates.

A major focus of the workshop will be the systematics of supernovae as distance indicators.
In order to deliver precise supernova distances, future surveys will need to achieve unpar-
alleled control of systematics affecting, e.g., calibration, photometry, reddening, evolution,
K-corrections, etc. A primary goal of the workshop will be to critically assess the progress
that has been made in quantifying systematics as well as the prospects and pathways for fur-
ther controlling them in future ground- and space-based surveys. Supernova survey datasets
are just now becoming large enough that one can begin to subdivide the samples to study
systematics in detail. A key focus of the workshop will be to discuss the early analyses along those lines, to take stock of what is being learned, and to discuss possibilities for refining those analyses in the future. The outcome of these discussions should help inform the planning and strategies of future surveys/missions.

Another aim of the workshop will be to objectively assess and compare the different methods of SN light-curve analysis that have been devised (e.g., $\Delta m_{15}$, stretch, MCLS, BATM, CMAGIC, etc.), something that has not been systematically done as yet. The goal will be to identify existing or develop new analysis methods that are both near-optimal and robust for the analysis of present and future supernova surveys.

Since future wide-area surveys will discover much larger numbers of supernovae than can be followed up spectroscopically, there is considerable interest in exploring the possibilities of SN distance measurements combined with purely photometric redshifts. We plan to discuss the prospects and methodologies for carrying out such projects, with particular concern for issues such as SN Ia sample purity.

Finally, there is growing interest in reviving/exploiting type II supernovae as distance indicators, a topic we also plan to cover in the workshop.

While we may not be able to cover all the above topics in excruciating detail over the course of two weeks (we want to keep the number of formal talk sessions relatively small, following Aspen tradition), they illustrate the range of important issues we hope to discuss in formal and/or informal sessions.

We note that a workshop on “Accretion and Explosion: The Astrophysics of Degenerate Stars” will be held at the KITP, Santa Barbara, from Feb. through May, 2007. While there is some topical overlap, the two workshops are in fact quite complementary: the KITP workshop will focus primarily on the Type Ia explosion mechanism, while the Aspen workshop will focus on supernovae as distance indicators.

- Likely participants:

To gauge the community interest in such a workshop, we contacted a subsample of astrophysicists working on supernovae. The following people (most of those we contacted) expressed enthusiasm for the concept and interest in participating:

Peter Hoeflich, Bob Kirshner, Mark Phillips, Peter Nugent, Adam Riess, Nick Suntzeff, Masao Sako, Lifan Wang, Ray Carlberg, John Tonry, Isobel Hook, Wolfgang Hillebrandt, Don Lamb, Bruno Leibundgut

Based on this positive response, we expect the workshop will have broad appeal to supernova observers and theorists, cosmology theorists, and astrophysicists more generally. We will aim to attract a diverse mix of junior and senior researchers.