How to Snowmass

Chris Quigg

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Particle physics, with its reliance on shared instruments, projects spanning decades, highly international character, and research teams that range from a few individuals to thousands, has a special need for inclusive, coherent planning. In the United States in recent decades, the High Energy Physics Advisory Panel has recommended priorities to the Department of Energy and the National Science Foundation, informed in part by wide-ranging community-based studies.

The Spirit of Snowmass Past

The Division of Particles and Fields of the American Physical Society provided a model for these community efforts in 1982, when it organized a *Summer Study on Elementary Particle Physics and Future Facilities* open to all active particle physicists in the United States, joined by representatives of the European physics community, the DOE, and the NSF. Some 150 participants gathered from June 28 to July 16, 1982 in the beautiful isolated setting of Snowmass, Colorado, a mountain resort above 2500 meters altitude.

In his Preface to the *Proceedings*, DPF Chair Charles Baltay wrote,

> "In some ways, the 1982 DPF Summer Study represents a new departure in the field of particle physics. In the past, studies were typically held by the large laboratories to address problems specific to that particular laboratory. The 1982 DPF Summer Study was the first attempt in recent years to bring together physicists from the whole country to consider the future of our field from the point of view of the best overall national program. The DPF Executive Committee feels that this summer study was sufficiently useful in this last respect to hold similar summer studies at appropriate times in future years."

The avowed purpose of Snowmass 1982 was to "assess the future of elementary particle physics, to explore the limits of our technological capabilities, and to consider the nature of future major facilities for particle physics in the U.S." The organizers did not aim to reach any specific decisions or to make detailed recommendations about particular future initiatives. Two important choices served Snowmass gatherings well for several decades. First, topics for study were arranged in a matrix—rows for physics and technology, columns for facilities, with mornings dedicated to one set, afternoons to the other. Participants were

encouraged to be active in one row and one column, to foster interactions. Second, formal meetings were minimized so the working groups could, in fact, do work.

Responding to the discovery of the W and Z bosons at CERN's S$\bar{p}$pS Collider, the imminent operation of the superconducting Tevatron, and the importance of exploring the 1-TeV scale, the 1983 HEPAP Subpanel led by Stan Wojcicki recommended immediate initiation of a multi-TeV high-luminosity collider—the Superconducting Super Collider—with the goal of experiments at the earliest possible date. At the *1984 DPF Summer Study on the Design and Utilization of the Superconducting Super Collider* held for three weeks at Snowmass, the community as a whole began to come to terms with the promise and challenges of the SSC and the experiments it would enable.

The pattern of extended residential studies at Snowmass continued with the *1986 Summer Study on the Physics of the Superconducting Supercollider*. By 1988, with the SSC seemingly well-launched and the Z factories approaching operation, the community began to pay increased attention to the program that should accompany the SSC. The *1988 DPF Summer Study on High-energy Physics in the 1990s* and *1990 DPF Summer Study on High-energy Physics: Research Directions for the Decade* explored this broader context.

In 1993, Fermilab and the SSC Laboratory co-sponsored a *Workshop on B Physics at Hadron Accelerators* on the Snowmass model, and the following year DPF, together with the Division of Astrophysics and the Division of Nuclear Physics organized a *Summer Study on Particle and Nuclear Astrophysics and Cosmology in the Next Millennium*.

To help the community regroup after the cancellation of the Superconducting Super Collider, DPF and the Division of Physics of Beams organized in 1996 a three-week *Summer Study on New Directions for High-Energy Physics* at Snowmass.

The most recent DPF-led community study on the mountain was the *2001 DPF / DPB Summer Study on the Future of Particle Physics*, which attracted more than 1200 participants, including more than eighty graduate students, more than two hundred "young physicists," and more than two hundred colleagues from outside the United States. Following HEPAP's adoption of the International Linear Collider as a goal, 668 enthusiasts gathered in 2005 for a Snowmass-style *International Linear Collider Physics and Detector Workshop and 2nd ILC Accelerator Workshop* under the aegis of the American Linear Collider Physics Group and the International Linear Collider Steering Committee.

For the *2013 Community Summer Study*, DPF introduced a new model: intense work and satellite meetings involving more than a thousand physicists through the academic year culminated in a nine-day plenary gathering at the University of Minnesota with nearly 700 participants. The work documented for *Snowmass 2013* proved enormously informative and influential for the Particle Physics Project Prioritization Panel that followed. *Snowmass 2021* has been launched by DPF on a similar plan, modulated by exigencies of the COVID-19 pandemic: many working groups are holding virtual meetings in anticipation of a ten-day-long gathering in July 2021 at the University of Washington campus in Seattle.

While the Division of Particles and Fields has taken the lead in organizing our community studies, the Snowmass tradition would not exist without the moral, financial, and material support provided by the funding agencies and our great laboratories, the collaboration of our international colleagues, and the partnership of other professional groups.

What Snowmass Can Do for You, and What You Can Do for Snowmass

The goals of Snowmass—and the outcomes—are defined by individual participants, led by the organizers. This year's announcement speaks of an opportunity for the entire particle physics community to come together to identify and document a scientific vision for the future of particle physics in the U.S. with our international partners. How can we make that happen? Let me offer some advice to first-time participants (and maybe others).

A first goal should be to broaden our horizons—to look beyond our current research problems, our collaborations, our institutions, and to learn from others about their ideas, institutions, and scientific styles. This came naturally when we lived and worked in close proximity to a wide range of colleagues for three weeks. It will require more effort for the truncated gathering in Seattle, and more dedication still if we should be constrained to meet virtually next summer. Mix! Learn! Teach! The chance to enlarge our conception of the field and develop solidarity with colleagues and their aspirations can be a precious outcome.

A certain amount of advocacy for projects or lines of research is inevitable, even desirable. Engage with initiatives other than your own and bring to them a fresh perspective. Probe for weaknesses, to be sure, but ask how you can make them stronger. My goal would be that every initiative might emerge better understood, improved, and taken more seriously after *Snowmass 2021* than before, and that the seeds of new initiatives might be gathered. Even if some ideas do not emerge as priorities today, they might in the future, so it is to our

advantage to develop them as convincingly as we can and to identify what needs to be done to bring them along.

Snowmass is a setting in which the whole community can investigate not only what is the physics we want to do, but what we need—infrastructure; collaboration with engineers and inventors in our universities, labs, and industry; electronics; detection methods; communications; computing hardware and techniques; a lively dialogue between theory and experiment—to do the best science. What can we learn from others, and what do we have to offer to others? This has special resonance at the interfaces of our field with neighboring sciences.

Advancing our science requires not only ideas and instruments, but also people. Already at *Snowmass 1982*, there were concerns about the size of collaborations, time scales for experiments and accelerators, and career opportunities. Attention to sociology and demographics is intrinsic to planning our future. The special challenge of the global financial crunch and the uncertainty of U.S. visa policies compromise careers. What should we know, and how can we turn that knowledge into effective action? How can we foster viable career paths for colleagues who design, build, and operate accelerators and detectors, and for those who create simulations, reconstruction algorithms, and other essential software? In the same spirit, we urgently need a clear-eyed assessment of Diversity, Equity, and Inclusion. What can we do, individually and collectively, to strengthen our discipline by making it attractive and welcoming to all?

The gathering of the community that we are preparing creates opportunities for public outreach and education, as well as for education within our own community. That is not only part of our obligation to our fellow citizens, it is an opportunity for all of us to share the joy of our fascination with exploring and understanding nature.

It is not too soon to think about what you will do after *Snowmass 2021*. Here is some advice I offered to participants in *Snowmass 2001*.

Continue to think about what you have heard and done at Snowmass. Talk with your particle-physics colleagues about what you have seen and heard and done here. Arrange seminars to share the Snowmass experience with all your students and colleagues.

Talk with your colleagues in other fields of physics and astronomy about Snowmass. Share your enthusiasm! Give a colloquium early in the school year about the future of particle physics.

Talk with your colleagues in other fields about their excitement and aspirations. Help your students appreciate the exciting futures all across physics and astronomy.

You will meet many gifted, articulate, and inspiring colleagues through Snowmass: Invite them to visit your department. Hire them!

In the meantime, work hard, have fun, make yourself a better scientist, and help create a bright future for particle physics!