SCIENCE —

AAAS: Large-scale collaborations in physics

Physics today is expensive and requires a great deal of expertise. A symposium ...

MATT FORD - 2/16/2008, 6:15 AM

This symposium focused on six separate large-scale, ambitious, physics projects—CERN and the LHC, the International Linear Collider (ILC), ITER, the James Webb Space Telescope, and the Atacama Large Millimeter Array. Each project has something in common: they are collaborations between many nations and international groups, and none owned by one person or body.

The first lecture I attended here was given by Dr. Robert Aymar, the director general of CERN. He began by pointing out that CERN began over 50 years ago and, even then, consisted of 12 European member states. His lecture focused on the Large Hadron Collider (LHC), its role in the future of high energy physics, and he laid out examples of collaborations that the LHC has undertaken. As an example, he used the CMS detector experiment—one of four on the LHC main ring—which has been worked on by over 2,300 scientists from 175 institutes and 38 countries, with the cost shared by all who worked on it. He went on to lay out what he termed three models of international collaboration.

The first model was termed "Individual Interest." This is the traditional way of doing science, where people carry out experiments and theoretical work while bringing others in to train on their equipment and participate in an exchange of ideas, experience, and culture. In this model, multiple simultaneous collaborations occur across state and country borders. The second model he termed "Collective Interest," and he cited the Large Hadron Collider as an example. In this model, there is a collection of parties but a unique host. The infrastructure is built and run through a consensus of the members of the project. Its uniqueness, aim, and scope are also decided by the partners in the work.

The successful completion of the project must be guaranteed by the host and, should a member drop out, the host must pick up the slack. The benefit of this is that the risk is shared among many. The payoff is that the results are freely and equally available to all who contribute, regardless of level. The final "Equipartition model" described what he termed "the dream." It is a simple extension of the "Collective Interest" model, except there is no host site, and all members must give equal contributions and receive equal rights. To date, according to Dr. Aymar, no projects are carried out using this model exclusively.

The remainder of the symposium consisted of members of other large-scale projects discussing how they work in an increasingly international world. The International Linear Collider was discussed by Dr. Barry Barish of CalTech. This project will will slam positrons and electrons into each other in a way that is intended to build on the data collected in experiments carried out at the LHC. Ideally, it will allow us to study the Higgs boson in detail, among other things. According to Dr. Barish, the LHC will lead the way and have large, broad reach, while the ILC will provide a second look with higher levels of precision.

The next major undertaking discussed was the ITER reactor being built in southern France. Those involved hope this will be the first industrial-scale fusion reactor. Introduced by Dr. Norbert Holtkamp, ITER's goal is to produce a significant fusion power amplification in a long pulse operation (for ~1,000 sec). The researchers and engineers involved come from seven different geographic groups and hope to put 50 MW into the reactor, yet get 500 MW out in thermal energy.

The final two large-scale projects were not dealing with either high energy or energy production—they were a pair of telescopes being built to operate around and above this world. The first was the James Webb Space Telescope, Hubble's successor, being built by NASA engineers. While European countries and Canada are building pieces,and providing services for this telescope, NASA stated that they like to retain the majority of control on a project. This allows NASA to closely keep tabs on costs and schedules. The final endeavor presented at the symposium was the Atacama Large Millimeter/submillimeter Array (ALMA), a series of telescopes that are being built high in the mountains of Chile. Dr. Anneila Sargent of Caltech stated that funding and expertise has come from Europe (ESO), the USA, Canada, Japan, Taiwan, and Chile, and is a close approximation of Dr. Aymar's equipartition model. When completed, it will consist of 54 12m antennas and 12 7m antennas, and should provide new insights into the cosmos.

As physics projects become larger and larger and the technical challenges become greater, these collaborative models provide a way to share both the risks and the rewards among a group of interested partners. These ideas may be the new face of modern physics—in a completely unrelated morning session, there was a call for a large-scale international collaboration to take up the job of space exploration.

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