To put the $6 billion cost of the Superconducting Super Collider in perspective, it is interesting to note that there are roughly 4000 members of the APS division of particles and fields. Thus the Super Collider would represent a capital expenditure of roughly $1.5 million per high-energy physicist. Even this figure is an underestimate, for the following reasons: There is considerable cross-membership between divisions, so that some members of DPF are not primarily particle physicists; many DPF members are theorists who would not be directly using the Super Collider; and many experimentalists in DPF would be using other facilities, like SLAC and CERN, rather than the Super Collider. It is interesting to contemplate what results might be achieved in other fields, such as condensed matter physics, or for that matter molecular biology or AIDS research, if a capital expenditure of $1.5 million per researcher were made.

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2/88

Justice for a Discredited Figure

The Search and Disovery piece on small tunnel junctions and single electrons in the May issue contains a figure (page 21) adapted from a figure I provided. I regret that I failed to inform the writer, Barbara Levi, that the data contained in the figure are the product of a collaboration among Peter L. Gammel, David J. Bishop, Gerald J. Dolan and myself. I apologize to my coworkers for the injustice done to them as a result of this omission.

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6/88

The Truth About Lie Groups

After reading John H. Schwarz's article on superstrings (November 1987, page 33), I still can't accept the concept—nature comes with no strings attached. But that is not the purpose of my letter. Schwarz makes a mistake in listing the simple Lie groups. In so doing, he simply repeats the error made by many physicists before him.

Schwarz lists the simple groups as the "orthogonal" sequence, the "unitary and symplectic sequences" plus the exceptional groups. Sheldon Glashow[1] gives the same list of simple Lie algebras, which he claims contains all the simple Lie algebras. In his book *Grand Unified Theories*, Graham Ross[2] states that "the possible simple Lie algebras have been classified by Cartan and correspond to the infinite sequences of groups $SU(n+1)$, $SO(2n+1)$, $SP(2n)$ and $SO(2n)$, where n is a positive integer, together with five exceptional groups." Unfortunately, these lists are wrong, for they contain only the simple compact Lie algebras. Perhaps more unfortunate is the fact that this misunderstanding has been perpetuated among the physics community for so long and appears in so many places.

Elie Cartan classified the complex Lie algebras. Each complex Lie algebra has several real forms, and among these real forms, there is only one compact real form. A real Lie algebra may be complexified, and two different real Lie algebras may have the same complexification. What the above authors have listed are the compact real forms of the simple complex Lie algebras from Cartan's classification.[3]

Let me give an example that I believe is important in the quest for unification. Howard Georgi and Glashow[4] gave several criteria for a group to satisfy. They claimed that SU(5) was unique in satisfying those criteria. Now SU(5) is the compact real form of Cartan's A_4. Other real forms of A_4 are SU(4,1) and SU(3,2). All three of these algebras are simple; only SU(5) is compact. The question for unifiers then is, which real form of A_4 is important? Georgi and Glashow argue the case for SU(5), but forget to explicitly mention their compactness hypothesis. Calvin S. Kalman[5] and E. Athanassakos and Kalman[6] argue the case for SU(4,1), while I have argued the case[7] for SU(3,2). These groups were also mentioned by Daniel Beau and Salah Horachi[8] as one of a class of groups capable of unifying external and internal symmetries.

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