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Who broke electroweak symmetry?

Who broke electroweak symmetry? This question may sound rather naive, yet the discourse about the "spontaneous" breaking of electroweak symmetry entails a reference to agency which finds implicit expression in the often repeated (and equally often criticized) statement that the particles of the Standard Model "acquire" their mass "thanks to" the Higgs boson. The implicit agency manifests itself in its most extreme form in the nickname happily bestowed on the Higgs boson in the popular press: "the God particle".

The construction of spontaneous symmetry breaking can be analysed as the interplay between different mathematical formalisms, phenomena of various nature and verbal statements connecting the whole and endowing it with physical meaning. One may argue that the latter, verbal component played a key role in the development of the notion of spontaneous symmetry breaking, spinning a narrative which allowed to close gaps in mathematical arguments and downplay the arbitrariness of analogies between phenomena. From this process emerged an ambiguous mathematical-physical notion which was to become the symbolic carrier of a "mechanism of mass generation".

In the papers quoted as the origin of spontaneous symmetry breaking Yoshiro Nambu and Giovanni Jona Lasinio used an analogy to super-conductive systems to interpret the masses of strongly interacting particles as expression of an exact, but hidden symmetry (N 1960, N/JL 1961). They did not speak of "symmetry breaking" - let alone a "spontaneous" one - but rather of the existence of "superconductor solutions" to the equations for particle self-energy. Jeffrey Goldstone (1961) reformulated their arguments in terms of an elementary scalar field with non-zero vacuum expectation value, but it was Marshall Baker and Sheldon Glashow (1962) who framed the issue as "spontaneous symmetry breaking", attempting to explain mass values in terms of "stable self-generated solution" of quantum-field-theoretical equations. Neither in solid state nor in particle physics was it possible to explicitly compute such solutions, yet Glashow and Baker exploited the phenomenological success of superconductivity theory to suggest that the procedure of going from symmetrical equations to unsymmetrical "superconductor solution" could be interpreted as a physical, natural process in the spirit of the then-popular "bootstrap philosophy", where fundamental laws were determined by self-consistency conditions.

Later on, spontaneous symmetry breaking came to be expressed in terms of an elementary scalar field, as Goldstone had done, and the "Higgs mechanism" emerged, where no hypothetical self-generating solutions of equations were introduced, and spontaneous symmetry breaking "occurred" when a classical Lagrangian was quantized around one field-configuration instead of another one. Thus, the choice between a higher and a lesser symmetry could not be assumed to be made by nature, but seemed rather to be left in the hands of the scientists. Yet the powerful explanatory narrative of a self-consistent, spontaneous agency at the origin of symmetry breaking - and of mass - survived, leaving the "God particle" to act as a place-holder for the agent.