



Nobel Prize 2021: Physics

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Syukuro Manabe (b. 1931), Ph.D. 1958, Tokyo. Princeton University, USA.

Klaus Hasselmann (b. 1931), Ph.D. 1957, Göttingen. Max Planck Institute for Meteorology, Hamburg, Germany.

Giorgio Parisi (b. 1948), Ph.D. 1970, Rome. Sapienza University of Rome, Italy.

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On October 5, 2021 the Royal Swedish Academy of Sciences announced the winners of the 2021 Nobel Prize in Physics. The award recipients were Klaus Hasselmann of the Max Planck Institute for Meteorology in Hamburg, Germany, Syukuro Manabe of Princeton University, USA, and Giorgio Parisi of Sapienza University of Rome, Italy.

Hasselmann and Manabe each received one-quarter of the prize for “the physical modelling of Earth's climate, quantifying variability and reliably predicting global warming”. Parisi received the other half of the Nobel prize for “the discovery of the interplay of disorder and fluctuations in physical systems from atomic to planetary scales” [1]. Although at first-glance it may seem that the two fields are not directly related, both areas involve the study of complex chaotic systems which are notoriously difficult to study over long time periods. Manabe and Hasselmann's work studied complex systems on the larger scale, and Parisi's work on the small scale, but can be applied to larger scales.

In the 1960s Syukuro Manabe developed models which illustrated that increased carbon dioxide content in the atmosphere leads to increased atmospheric temperatures. He was also a pioneer in exploring the non-trivial interplay between radiation balance and the vertical transport of air masses and his work is considered foundational in modern climate modelling. Hasselmann's work studied foundational issues which help today's scientists better understand Earth's climate change, one of the most pressing issues today. From his work one can identify specific clues indicating that natural phenomena as well as human activity can have significant effect on the climate. Like Manabe, Hasselmann's work has also been used to show that the increased carbon dioxide content in the atmosphere is increasing the global temperature and that human emissions are contributing to this.

Giorgio Parisi's share of the Nobel prize is related to his studies of spin glasses. Spin glasses are complicated systems of interacting atoms which tend to generally be disordered (have no discernible pattern) and this disorder makes them difficult to study. Parisi showed that properties exist in the possible configurations of such systems that allows one to classify and sort the systems into partially similar states (referred to as replicas). The problem then becomes one of essentially studying how one such state can be transformed into another such state. Although this may not seem closely related to climate science this concept has wide application to other complex systems such as biology and weather. Like spin glasses you there also have a large number of interacting quantities which are disordered.

[1] The Nobel Prize in Physics 2021. NobelPrize.org. Nobel Prize Outreach AB 2021. Wed. 3 Nov 2021.
<<https://www.nobelprize.org/prizes/physics/2021/summary/>>

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