

## Aging, rejuvenation and memory effects in glassy systems

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In this talk, we shall introduce spin glasses and review the general experimental features of their glassy dynamics [1]. We shall use spin glasses as a guideline for enlightening the behaviour of a few other disordered systems, like suspensions of interacting magnetic nanoparticles (which are presently under investigation [2]), structural or polymer glasses, gels, etc.

Spin glasses are model magnetic systems in which the interactions are disordered and frustrated, due to a random dilution of magnetic ions. Below their glass temperature  $T_g$ , the response to a magnetic excitation is a slow relaxation of the magnetization, which strongly depends on the time spent below  $T_g$  (« aging » phenomenon). The effect on aging of the cooling procedure presents several interesting features. During cooling, each further step down tends to restart some aging processes (« rejuvenation »), while the memory of previous aging stages achieved at different temperatures during cooling can be retrieved when re-heating [1]. It is possible to store independently several memories, which corresponds to imprinting the trace of various spin arrangements at well separated length scales that are selected by temperature [3,4].

Similar aging, rejuvenation and memory phenomena can be observed in many other glassy systems, making the spin glasses conceptually simple examples for the study of out-of-equilibrium dynamics in disordered systems.

[1] see references in E. Vincent, Lecture notes in Physics **716** 7-60 (Springer-Verlag, Berlin, 2007), also accessible at <http://arxiv.org/abs/cond-mat/0603583> .

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