



Gaia will address a broad range of physical and astrophysical topics related to stellar structure and evolution. Pictured here: the Hipparcos Hertzsprung–Russell diagram of the Hyades compared to a model isochrone. Uncertainties in the stellar parameters and in the calculation of model atmospheres and interiors affect the determination of the cluster age and helium content.

The study of stellar structure and evolution provides fundamental information on the properties of matter under extreme physical conditions as well as on the evolution of galaxies and cosmology. The accurate and homogeneous astrometric and photometric data provided by Hipparcos has resulted in precise characteristics of individual stars and open clusters and the confirmation of certain aspects of internal-structure theory.

Further progress on stellar modelling is required, for example, on atmospheric modelling, transport processes of matter, angular momentum and magnetic fields, microscopic physics, etc. On the observational side, more numerous samples of rare objects, including distant stars and stars undergoing rapid evolutionary phases, an increased number of common objects with high-quality data, and a census over all stellar populations are required.

Gaia will return luminosities, surface temperatures, abundances, masses, and determinations of the interstellar extinction for all types of stars. The following are some of the effects that will be probed with the Gaia data:

**The size of convective cores:** Asteroseismic data – obtained from the ground or from the space mission COROT – combined with accurate estimates of global parameters from Gaia can probe the size of stellar convective cores. These define the amount of nuclear material available to sustain the luminosity, playing a crucial role in the evolution of intermediate- and high-mass stars.

**Internal diffusion of chemical elements:** Microscopic and turbulent diffusion of chemical elements in stellar radiative zones may have important consequences for stellar evolution, in particular for stellar ages when fresh helium is brought to the stellar cores. Diffusion may also modify the composition at the surface of stars during their life implying difficulties in linking abundances of elements presently observed to the initial abundances of the protostellar cloud.

The high-precision positions in the Hertzsprung–Russell diagram of stars of known surface abundances, provided by Hipparcos and by high-resolution spectroscopy, have revealed discrepancies between the observations and the predictions of standard stellar models. The large sample of stars with accurate parameters provided by Gaia will help in addressing these discrepancies.

**Outer convective zones:** Most stellar models are still built by treating convection according to the classical parametric mixing-length theory. Asteroseismic analysis of stars combined with the careful calibration of the Hertzsprung–Russell diagram allowed by Gaia for samples of different chemistries, ages, etc., will greatly enhance our capabilities of dealing with non-local convective models for stellar interiors.