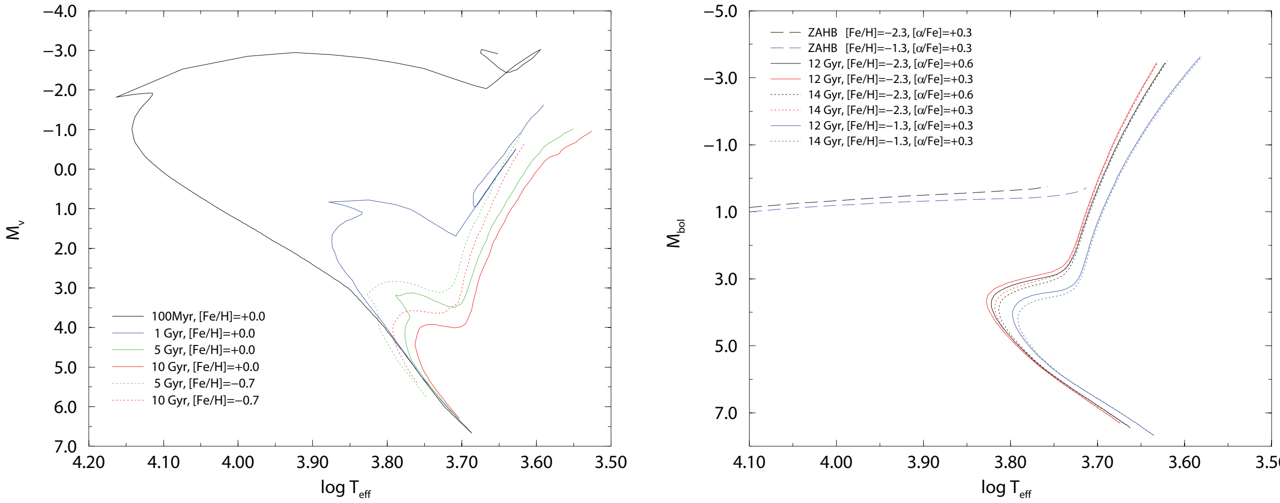

Gaia photometry will allow chemical-abundance and age determination of the Galactic stellar populations over the entire Hertzsprung–Russell diagram. Left: isochrones of 0.1, 1, 5, and 10 Gyr covering the thin disc and the bulge. Right: isochrones of 12 and 14 Gyr and zero-age-horizontal-branch loci for several [Fe/H] and [α/Fe] abundances suitable for the halo and the thick disc.

If Gaia's astrometric measurements would be unsupported by appropriate diagnostic data, the final Catalogue would contain immense numbers of positions and velocities of objects whose astrophysical nature would otherwise be unknown. With such limited data, the key objective of the mission – the study of the structure and history of the Milky Way – could not be met. Therefore, Gaia has therefore been equipped with a photometric instrument with the goal of measuring the spectral energy distributions of all objects. From these measurements, astrophysical quantities such as luminosity, effective temperature, mass, age, and chemical composition can be derived.

In order to meet the astrometric performance requirements, the measured centroid positions must be corrected for systematic chromatic shifts induced by the optical system. This is only possible with the knowledge of the spectral energy distribution of each observed target in the wavelength range covered by the CCDs of the main astrometric field ($\sim$330–1000 nm). The photometric instrument also covers this requirement.

Photometric measurements are indispensable in providing the basic tools for classifying stars across the entire Hertzsprung–Russell diagram, as well as in identifying specific and peculiar objects. To achieve this, it is necessary to observe a broad spectral domain, extending from the ultraviolet to the infrared. Gaia's photometric measurements must be able to determine, among others, (i) effective temperatures and reddenings for early-type stars, which serve both as effective tracers of Galactic spiral arms and as reddening probes; (ii) effective temperatures and abundances for late-type stars; and (iii) luminosities for stars with large relative parallax errors. Moreover, in order to be able to reconstruct the Galactic formation history, the distribution function of stellar abundances must be determined to $\sim$0.2 dex, while effective temperatures must be obtained to $\sim$5%. These accuracies allow separation of stars belonging to the various stellar populations in the Galaxy (i.e. thin disc, thick disc, and halo). The determination of abundances of Fe and α-elements is essential for mapping Galactic chemical evolution. Photometric measurements will be performed for every target transiting the focal plane. Hence, astrophysical information will not be limited to stars but will also be available for quasars, solar-system objects, and many other celestial bodies.

A broad-band magnitude, and its time dependence, can be obtained from the analysis and rigorous calibration of the primary mission data (i.e. by determination of the 'amplitudes' of star images in the main astrometric field). Combined with parallaxes and with estimates for interstellar absorption, these so-called G-band magnitudes give a measure of the absolute magnitude. Gaia will provide reliable absolute magnitudes for several hundred million stars.