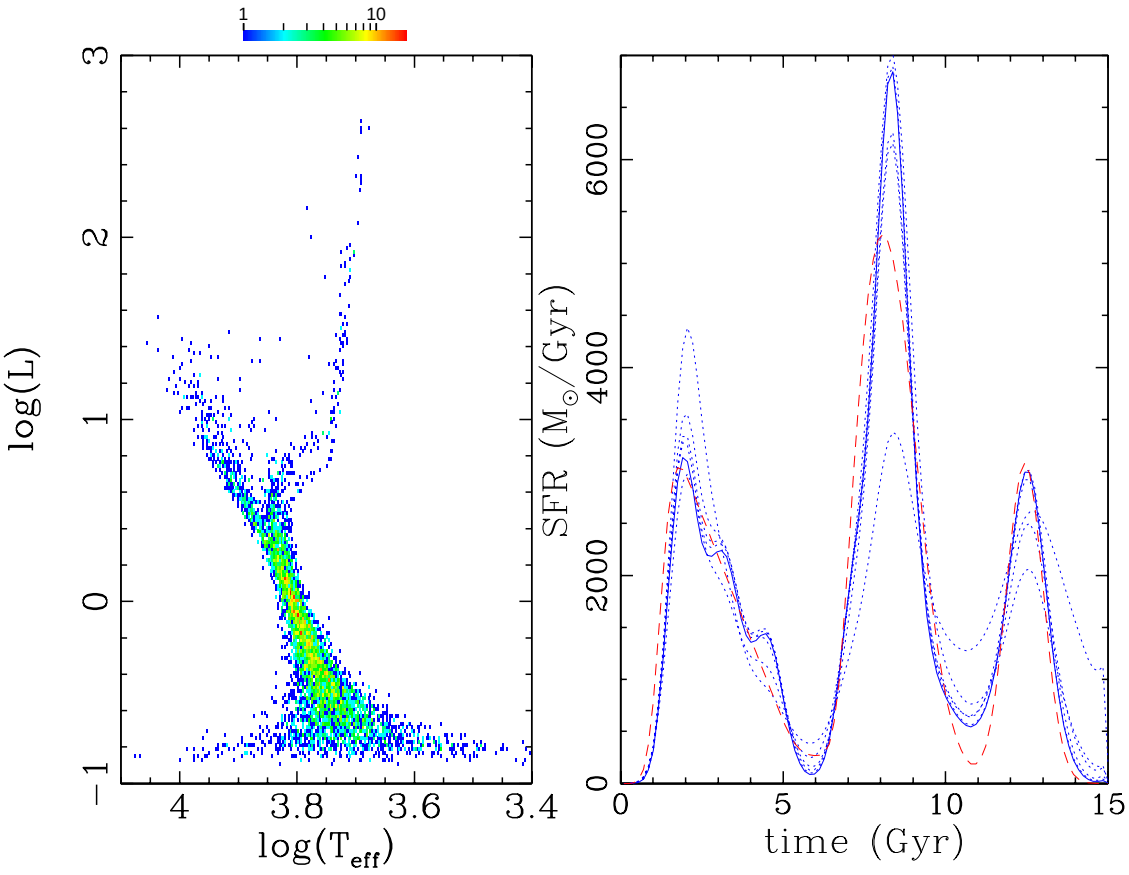

Left: synthetic Hertzsprung–Russell diagram appropriate for good-quality Gaia data. Right: derived star-formation history following inversion of the data in the left panel. Long-dashed red curve: true input star-formation history; dotted curves: successive intermediate iterations; solid curve: final iteration.

A primary scientific goal of Gaia is the determination of the star-formation histories, as described by the temporal evolution of the star-formation rate and the cumulative numbers of stars formed, in the bulge, inner disc, solar neighbourhood, outer disc, and halo of the Milky Way. In general, stellar age-metallicity-extinction degeneracies, convolved with current observational errors and uncertain stellar distances, have made determination of the star-formation history of a mixture of stellar populations unreliable and non-unique. The best available analyses involve comparison of an observed colour-magnitude diagram with a model population. While powerful, such analyses can never be proven unique. The Gaia astrometric, photometric, and spectroscopic data, combined with specifically-developed, direct-inversion tools, will resolve this ambiguity and will make the full evolutionary history of the Galaxy accessible.

The star-formation history defines the luminosity evolution of the Galaxy directly. In combination with the relevant chemical abundance distributions, the accretion history of gas may be derived. Together with kinematics, the merger history of smaller stellar systems can be defined. The sum of these three processes forms what is loosely known as 'galaxy formation'. Analysis of the Gaia results will provide the first quantitative determination of the formation history of our Galaxy.

The determination of the relative rates of formation and/or accumulation of the stellar populations in a large spiral, typical of those galaxies which dominate the luminosity in the Universe, will provide, for the first time, an ability to test galaxy-formation models in a quantitative manner. Do large galaxies form from accumulation of many smaller systems which have already initiated star formation? Does star formation begin in a gravitational potential well in which much of the gas is already accumulated? Does the bulge pre-date, post-date, or is it contemporaneous with the halo and inner disc? Is the thick disc a mix of the early disc and a later major merger? Is there a radial age gradient in the older stars? Is the history of star formation relatively smooth or highly episodic? In addition to their immediate and direct importance, answers to such questions will provide uniquely a template for analysis of data on unresolved stellar systems, where Gaia-type and -quality data can never be obtained.