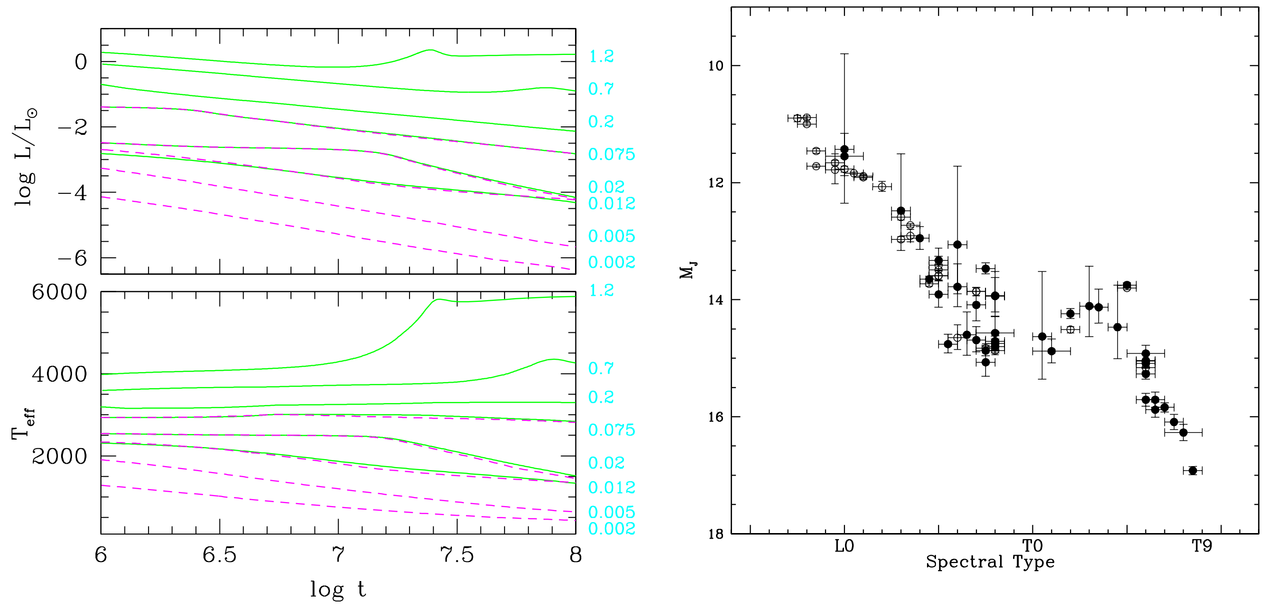

Left: the evolution of the luminosity (top) and effective temperature (bottom) as function of time (in yr) of brown dwarfs for different masses (shown on the right of this figure, in blue, in units of the solar mass). The solid green lines assume no dust formation; the dashed pink lines permit dust formation and retain it in the atmosphere. Gaia will measure accurate properties for young brown dwarfs in numerous clusters and star-forming regions (Baraffe et al. 2002, A&A, 382, 563). Right: absolute J-band magnitudes of field brown dwarfs obtained from ground-based astrometry and photometry. Late-L and T dwarfs are very faint in the optical, so Gaia will only be able to detect a limited sample of old field brown dwarfs out to several parsec. Yet even for these, Gaia will measure distances to better than 1% (Vrba et al. 2004, AJ, 127, 2948).

In observing the entire sky down to 20-th magnitude, Gaia will observe large numbers of isolated brown dwarfs in the solar neighbourhood. Structural models show that brown dwarfs cool and fade rapidly after formation, so that the distance out to which Gaia can detect them is a function of their mass and age. Gaia should see Pleiades-age (∼100 Myr) brown dwarfs out to around 400 pc and younger brown dwarfs, such as those in the Orion Nebula Cluster (1–3 Myr), out to about 1 kpc. This volume encompasses numerous young clusters and star-forming regions such as Chamaeleon, where brown dwarfs are known to exist. For an I = 20 mag brown dwarf at 200 pc, Gaia will obtain a distance accuracy of about 4% and transverse velocities to around 0.2 km s^{-1}.

One of the main contributions of Gaia to substellar astrophysics will be a detailed spatial and kinematic map of brown dwarfs in clusters of known age and metallicity (determined from Gaia parallaxes of higher-mass stars), permitting a comprehensive study of mass segregation and ejection of brown dwarfs. These are key ingredients to understanding the formation mechanism of substellar mass objects, whether it be via cloud fragmentation and gravitational collapse, premature ejection from an accreting envelope, or some other mechanism.

Brown dwarfs will be identified primarily from their absolute luminosities obtained from the precise Gaia parallaxes as well as from the on-board multi-band photometry. The latter will provide physical parameters of brown dwarfs, in particular the effective temperature, but perhaps also metallicity and the nature of cloud coverage. As brown dwarfs will be found in clusters of a range of ages, a significant contribution of Gaia will be an accurate observational determination of their cooling curves. The photometry and absolute magnitudes will furthermore help in the detection of spatially and astrometrically unresolved brown-dwarf binaries. From this information, we will be able to determine the substellar mass function and the three-dimensional spatial and age distribution of brown dwarfs, thus establishing their formation history in the context of the Galaxy.

Predictions of the number of brown dwarfs which Gaia will detect depend sensitively on their cooling function and their distribution. Rough estimates based on current knowledge are of the order of 50,000 over a wide range of masses and ages. The absolute luminosities, colours, and kinematics obtained from Gaia will provide us with detailed insight into the physical properties, formation, and evolution of this substellar population.