Abstract

The Andromeda Galaxy (M31), our nearest large galactic neighbour, offers a unique opportunity to test how mergers affect galaxy properties. M31's stellar halo caused by the tidal disruption of satellite galaxies is the best tracer of the galaxy's accretion history. Despite a decade of effort in mapping out M31's large stellar halo, we are unable to convert M31's stellar halo into a merger history. Here we use cosmological models of galaxy formation to show that M31's massive and metal-rich stellar halo containing intermediate age stars implies that it merged with a large (M* ~ 2.5 x 10^10 M_sun) galaxy ~2 Gyr ago. The simulated properties of the merger debris help to interpret a broader set of observations of M31's stellar halo and satellites than previously considered: its compact and metal-rich satellite M32 is the tidally-stripped core of the disrupted galaxy, M31's rotating and flattened inner stellar halo contains most of the merger debris, and the giant stellar stream is likely to have been thrown out during the merger. This accreted galaxy was the third largest member of the Local Group. This merger may explain the global burst of star formation ~2 Gyr ago in the disk of M31 in which ~1/5 of its stars were formed. Moreover, M31's disk and bulge were already in place before its most important merger, suggesting that mergers of this magnitude do not dramatically affect galaxy structure.