Title

Mapping the magnetic field of the coldest radio-detected brown dwarf

Abstract

Brown dwarfs are known to emit highly circularly polarised radio emission through the electron cyclotron maser instability. We have developed a novel algorithm to invert the magnetic field topology of such objects using the time-frequency structure of their radio emission. Here, we propose to observe WISE J062309.84-045624.6 (WISE J0623 hereafter), the coldest brown dwarf detected to date at radio frequencies. WISE J0623 is particularly suited to this method to map the magnetic field, as it is bright enough to determine the light curve structure with a high signal-to-noise ratio. From previous observations, its light curve cannot easily be reproduced by the auroral ring model used for Jupiter and other radio-detected brown dwarfs, but is instead well described by a model with a single active field line. Such a configuration can be reproduced with an unusual magnetic field topology, a stochastic process analogous to prominences, or with an interaction with a companion. We propose to observe WISE J0623 with MeerKAT for 30 hours, at 0.5-2.6 GHz using subarrays, to characterise the topology of the magnetic field of a cold brown dwarf and study its evolution over time, providing an essential step in understanding the dynamo processes generating magnetic fields in the coldest brown dwarfs and exoplanets, and, for the first time, determining whether the radio emission originates from a stable magnetic field, stochastic processes such as prominences, or a companion.