Abstract

Why don’t birds get lost on their long migratory flights? Scientists have been puzzled by it for centuries. While there have been many studies, no conclusive explanation is available so far. Here, we present an entirely new perspective on the mechanism of migratory navigation.

German scientists in the early last century discovered that a considerable proportion of migratory birds return to their natal or previous breeding places in subsequent years. People therefore believe there must be a mechanism for the migrants to determine the direction towards their goal, and currently consider a magnetic protein may play the role of “compass”. However, the orientation of such “compass needle” is completely overwhelmed by thermal fluctuations at birds’ body temperature.

To overcome inevitable flaws in all putative mechanisms, we start with investigation on the role of ferric-sulfide cluster in the newly discovered protein complex (Drosophila-CG8198), and derive a new type of four-level system depending on two parameters: magnetic and electric fields. We then solve an iconic problem of quantum optics in open system: the resonance fluorescence of the

derived four-level system interacting with environment and a driving field. An ingenious use of distinct features of our result reveals a compass-free mechanism: the separation of peaks in fluorescent spectra relates current location and destination, the change of such separation determines right direction to move, and double-resonance peaks appear when reaching the natal site.

Our approach opens up a new avenue for electrically tunable magnetic sensors, which will also inspire the design of possible manmade practical devices or robots.