Magnon condensation in a dense nitrogen-vacancy spin ensemble

The feasibility of creating a Bose-Einstein condensate of magnons using a dense ensemble of nitrogen-vacancy spin defects in diamond is investigated. Through assessing a density-dependent spin-exchange interaction strength and the magnetic phase-transition temperature ($T_c$) using the Sherrington-Kirkpatrick model, the minimum temperature-dependent concentration for magnetic self-ordering is estimated. For a randomly dispersed spin ensemble, the calculated average exchange constant exceeds the average dipole interaction strengths for concentrations approximately greater than 70 ppm, while $T_c$ is estimated to exceed 10 mK beyond 90 ppm, reaching 300 K at a concentration of approximately 450 ppm. On this basis, the existence of dipole-exchange spin waves and their plane-wave dispersion is postulated and estimated using a semiclassical magnetostatic description. This is discussed along with a $T_c$-based estimate of the four-magnon scattering rate, which indicates magnons and their condensation may be detectable in thin films for concentrations greater than 90 ppm.

General information
State: Published
Organisations: Department of Physics, Quantum Physics and Information Technology
Contributors: El-Ella, H. A. R.
Number of pages: 12
Publication date: 2019
Peer-reviewed: Yes

Publication information
Journal: Physical Review B
Volume: 99
Issue number: 2
Article number: 024414
ISSN (Print): 1098-0121
Ratings:
BFI (2019): BFI-level 1
Web of Science (2019): Indexed yes
BFI (2018): BFI-level 1
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 3.34 SJR 1.604 SNIP 1.04
Web of Science (2017): Impact factor 3.813
Web of Science (2017): Indexed yes
Scopus rating (2016): CiteScore 3.16 SJR 2.339 SNIP 1.151
Web of Science (2016): Impact factor 3.836
Web of Science (2016): Indexed yes
Scopus rating (2015): CiteScore 2.8 SJR 2.377 SNIP 1.13
Web of Science (2015): Impact factor 3.718
Web of Science (2015): Indexed yes
Scopus rating (2014): CiteScore 3.3 SJR 2.762 SNIP 1.316
Web of Science (2014): Impact factor 3.736
Web of Science (2014): Indexed yes
Scopus rating (2013): CiteScore 3.55 SJR 2.813 SNIP 1.326
Web of Science (2013): Impact factor 3.664
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
Scopus rating (2012): CiteScore 3.57 SJR 3.173 SNIP 1.378
Web of Science (2012): Impact factor 3.767
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
Scopus rating (2011): CiteScore 3.61 SJR 3.326 SNIP 1.423
Web of Science (2011): Impact factor 3.691
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes