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Critical Spin Dressing

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It has long been proposed [1] that spin dressing [2] could be employed to realize a highly effective helium-3 nuclear precession co-magnetometer for a neutron electric dipole moment search. The proposal requires application of an intense, continuous, and far off-resonant oscillating magnetic field in such a way that the apparent Larmor precession frequency of both species is modified. Under appropriate conditions a desirable situation known as critical dressing is anticipated: the neutron and the helium-3 nucleus (or more generally, any two spin species) are expected to behave as if they had the same gyromagnetic ratio and hence should precess at the same rate in a static magnetic field.

Spin dressing has been studied in the context of the neutron [3], helium-3 [4], and a variety of other systems [5]. Critical dressing, however, has not previously been demonstrated. We will present results from recent NMR experiments in which simultaneous dressing of ^1H and ^{19}F nuclei is studied, and in which critical dressing is observed. Insight gleaned from these experiments is expected to inform strategies for integrating critical dressing into a neutron electric dipole moment search.

[1] Phys Rep **237**, 1 (1994)

[2] J Phys (France) **30**, 153 (1969)

[3] Phys Rev Lett **58**, 2047 (1987)

[4] e.g. Phys Rev A **85**, 3 (2012); Phys Rev C, **76**, 5: 051302, (2007); and Phys Rev C, **84**, 2: 022501, (2011)

[5] e.g. Nature **471**, 83 (2011) or Nature **476**, 185 (2011)

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