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Quantum phase transitions in integer spin chains

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High field inelastic neutron scattering experiments on the $S=1$ bond-alternating 1D antiferromagnet NTENP, the anisotropic $S = 1$ -chain Haldane-gap compound NDMAP and the isotropic “composite” Haldane spin chain IPA-CuCl₃ [T. Masuda *et al.*, cond-mat/0506382] reveal key differences in the spin dynamics of these distinct types of quantum spin liquids. In modest applied fields the spectra of NDMAP [A. Zheludev *et al.*, Phys. Rev. Lett. **88**, 077206 (2002)] and IPA-CuCl₃ feature three sharp stable gap excitations. In contrast, in NTENP the highest mode is anomalously weak at $H = 0$ and rapidly broadens and vanishes when the field is turned on. Above the critical field of 1D Bose condensation of magnons and long-range ordering NDMAP retains a triplet of massive long-lived excitations [A. Zheludev *et al.*, Phys. Rev. B **68**, 134438 (2003)]. In IPA-CuCl₃ only two sharp gap excitations persist, with possibly an additional gapless mode. In NTENP only one sharp excitation branch is observed in this regime [Hagiwara *et al.*, Phys. Rev. Lett. **94**, 177202 (2005)], but there is new evidence of low-lying excitation continua. Work at ORNL was carried out under DOE Contract No. DE-AC05-00OR22725.