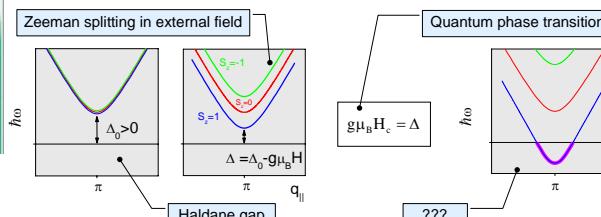


Bose condensation of magnons in anisotropic Haldane spin chains

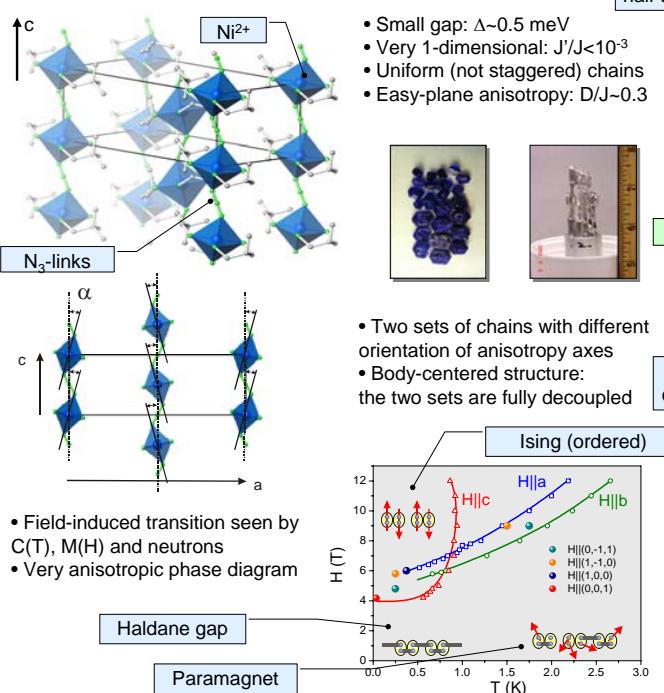
A. Zheludev (ORNL), C. L. Broholm (Johns-Hopkins, NIST), S. M. Shapiro (BNL), Z. Honda (Saitama U.), K. Katsumata (RIKEN), L.-P. Regnault, E. Ressouche, B. Grenier (CEA Grenoble), P. Vorderwisch (HMI), S. Park, Y. Qiu (NIST), A. Kolezhuk, H.-J. Mikeska (U. Hannover)

Haldane spin chain in a magnetic field



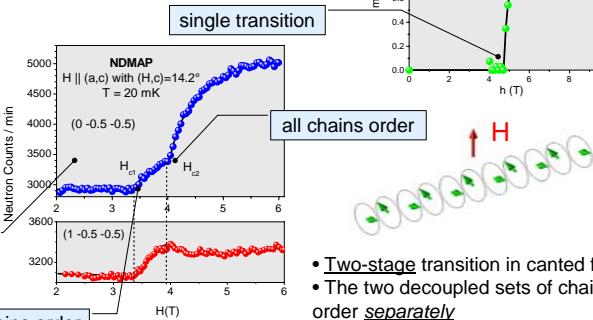
- Quantum phase transition equivalent to **1D Bose condensation**
- What is the nature of the high-field state?
- What are the excitations at $H > H_c$?

NDMAP: a perfect model compound



Field-induced antiferromagnetism

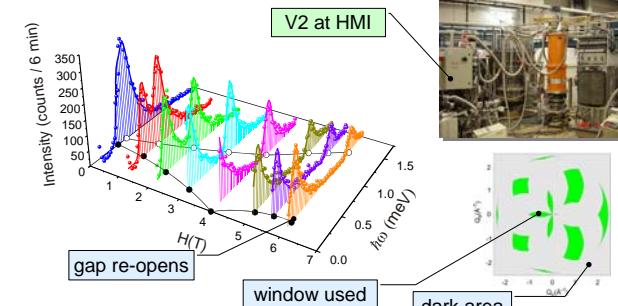
- New AF Bragg reflections at $H > H_c$
- Ordered moment is $\perp H$ and c-axis
- Rather large ordered parameter in modest fields



- Two-stage transition in canted field
- The two decoupled sets of chains order separately

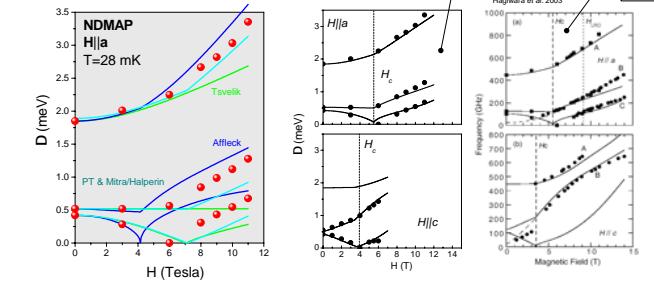
Dynamics in the high-field phase: $H \parallel c$

Dynamics in the high-field phase: $H \parallel c$



- Intrinsic tilt of anisotropy axes and in-plane anisotropy make the gapless quantum-critical XY high-field phase inaccessible

Comparison with theory



- Simple GL-type models qualitatively explain the observed behavior
- Several models differ in the way anisotropy is included
- A recent model originally developed for dimers seems to work best

Conclusion

The high-field phase of an anisotropic Haldane spin chain is a **quantum spin solid**

- Phys. Rev. B **69**, 054414 (2004)
 Phys. Rev. B **68**, 134438 (2003)
 Phys. Rev. Lett. **88**, 077206 (2002)
 Phys. Rev. Lett. **86**, 1618 (2001)
 Phys. Rev. B **63**, 104410(2001)