INTRODUCTION

1. OVERALL AIM
The Ketterle group at MIT have presented the first evidence for ferromagnetic phenomena in a cold atom gas [1]. To critically analyze their experimental results we:

- Compare experiment to mean-field and fluctuation corrected theory
- Understand how three-body losses renormalize the interaction strength
- Study the collective modes in a spin spiral to reduce three-body losses

2. EXPERIMENT & THEORY
The results in Fig. 1 show that with increasing repulsive interactions atoms are forced apart so their density drops and therefore their kinetic energy falls. At the ferromagnetic transition ($k_Fa=2$) the atoms enter the same Fermi surface so kinetic energy increases. Atom loss ($k_Fa^3n_1(n+n_1)$) rises before the transition as $(k_Fa)^3$, and in the ferromagnetic state falls as $n_1 \to 0$.

There is qualitative agreement with mean-field and fluctuation corrected theory [2,3]. However, there is a discrepancy in the critical interaction strength.

3. MEAN-FIELD DENSITY DROP
To minimize losses the experiment was performed rapidly. The topological defects in Fig. 2 condense out of the gas. They mutually annihilate but inhibit the formation of the ferromagnetic phase [2], which Fig. 1 shows raises the critical interaction strength to $k_Fa=2$.

4. DAMPING OF FLUCTUATIONS
Three-body loss also damps quantum fluctuations [4]. Fig. 3 shows how the loss rate renormalizes the effective interaction strength downwards. We therefore require a raised bare interaction strength $k_Fa=2$ to realize ferromagnetism.

5. COLLECTIVE MODES
To circumvent three-body loss the system could be started in a spin spiral (Fig. 4). This relaxes through collective modes growing normal to the spin spiral. By considering the feedback of the growing modes we recover the collective mode growth rates in Fig. 5.

REFERENCES

CONCLUSIONS
- Mean-field and fluctuation corrected theory are in qualitative agreement with experiment
- Topological defects inhibit the ferromagnetic transition
- Atom loss damps fluctuations so renormalizes the interaction strength
- A spin spiral circumvents atom loss and exhibits distinctive collective modes