

**Dynamics of Bose-Einstein condensates near a  
Feshbach resonance in  $^{85}\text{Rb}$**

by

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B.S., Wake Forest University, 1996

A thesis submitted to the  
Faculty of the Graduate School of the  
University of Colorado in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy  
Department of Physics

2003

This thesis entitled:  
Dynamics of Bose-Einstein condensates near a Feshbach resonance in  $^{85}\text{Rb}$   
written by Neil Ryan Claussen  
has been approved for the Department of Physics

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Eric Cornell

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The final copy of this thesis has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline.

Claussen, Neil Ryan (Ph.D., Physics)

Dynamics of Bose-Einstein condensates near a Feshbach resonance in  $^{85}\text{Rb}$

Thesis directed by Distinguished Professor Carl Wieman

I describe experiments with Bose-Einstein condensates (BEC) of  $^{85}\text{Rb}$  near a Feshbach resonance. The Feshbach resonance affects the collisions between atoms, allowing us to change the self-interaction energy of the BEC by applying a magnetic field. We used the Feshbach resonance to study the startling details of the BEC collapse after we abruptly switched the self-interaction from repulsive to attractive. This change caused a supernova-like implosion/explosion cycle, leaving behind a small remnant BEC. We also applied short magnetic field pulses toward the resonance to investigate the possibility of collisional coupling between atoms and diatomic molecules. We later created an atomic and molecular BEC superposition state and probed this state's coherence by applying two rapid magnetic field pulses. Careful measurements of the atom-molecule oscillation frequency allowed us to dramatically improve our determination of the Feshbach resonance parameters. All of these experiments have stimulated new theoretical work and have improved our understanding of the physics of resonant BEC.

## Dedication

This work is dedicated to my wife, Lisa, and to the rest of my family: Susie, Pete, Eric, Grant, and Craig.

## Acknowledgements

My time working at JILA has been greatly enriched by a number of people. First, I want to acknowledge my advisor, Carl Wieman. Carl has taught me a great deal about experimental physics and how to attack the many complex, real-world problems that occur in physics research. Carl's experimental skills and intuition are really amazing. Also, Carl nearly always has an optimistic viewpoint and his enthusiasm for exploring new areas is infectious. Another professor who has provided much advice and feedback is Eric Cornell. Eric was very involved in our experiments with  $^{85}\text{Rb}$  from the beginning. He took an active interest in our results, even when they seemed bizarre and hard to understand, as in our initial studies of BEC collapse. Eric often startles you with great ideas and insights into the BEC physics. I am impressed that Carl and Eric have continued to pursue their research goals so diligently despite the many other commitments they now possess after receiving the 2002 Nobel prize.

There are a number of other professors I would like to thank. On the experimental side of things, Debbie Jin has been a wonderful source for ideas and suggestions. Debbie has a cheerful attitude and she has a knack for asking questions that expose the holes in your thinking. Chris Greene has greatly improved my knowledge of physics. I really enjoyed his Math Physics course, which gave me my first and only taste of the fascinating aspects of group theory. I also appreciate Chris' patience with my seemingly endless questions about the scattering theory and Feshbach resonances. Murray Holland has shown similar patience with me as we discussed the intricacies of the pairing theory

he developed (with Servaas Kokkelmans) to explain our experimental data. Outside of work, I had a lot of fun as a soccer teammate of Murray's in the Boulder city recreational league, where Murray proved a very enthusiastic and agile striker. Another person I want to thank is John Bohn. In the times I saw him giving talks and in class, I really enjoyed John's sense of humor. I also had fun working with John on the written QM comps exam, even though no one decided to take our test!

The graduate students at JILA are a fantastic bunch of people. I especially enjoyed working "in the trenches" with Jake Roberts and Sarah Thompson. Jake taught me a lot about good experimental techniques — especially how to think about error bars. He was an excellent teacher in the lab and from what I have heard, also as a TA in the classroom. In addition, Jake has been a good friend of mine and we shared many trials and tribulations during the course of the first experiments with  $^{85}\text{Rb}$ . I hope that he will enjoy CSU and Rams football. Sarah Thompson joined our experiment shortly after Jake graduated. I've really enjoyed working with her for the past few years. She has a very strong aptitude for experimental physics and communicating with others. I am confident that she will continue to do great research in the future (hopefully the lab computers will stop crashing!) I have also learned a lot about exotic pets from Sarah.

Although I have not worked directly with them, there are many other grad students that I should acknowledge. Mike Matthews and Jason Ensher were fun to talk with and they were always full of laughs. Kristan Corwin was a good friend and a very enjoyable person to work with. Kurt Miller has always been ready to lend an ear to my comments and complaints. I appreciate his friendship and advice. I had a great time visiting Corsica for a BEC summer school with Heather Lewandowski and Paul Haljan. I think the tastes of the infamous "charcuterie du Corse" and fish soup will always stick with me, as will the sea-kayaking expedition. Brian DeMarco and Dirk Mueller were classmates of mine at JILA. I was always inspired by how well Brian spoke about physics and by his enthusiasm and skill for research. Dirk was a great

guy with a strong determination to succeed. He always seemed cheerful, no matter what the circumstances (except maybe at the end of our hike up Long's Peak). Brian, Dirk, and I had a tradition that I miss now — we would occasionally go out for a beer (preferably Guinness stout) and talk about practically everything under the sun. I have really enjoyed getting to know Scott Papp and Josh Zirbel after they took up residence across the hall on the new  $^{85}\text{Rb}$  experiment. I am excited to see what interesting results will come out of their 2nd generation BEC experiment. I also enjoyed all of the rock climbing expeditions with Josh and the planning for the ascent of Devil's Tower (Oh yeah!) Other grad students that I was privileged to know while at JILA are Chris Myatt, Rich Ghrist, Kurt Vogel, Ian Coddington, David Harber, Peter Schwindt, Ying-ju Wang, Jonathan Goldwin, Josh Dunn, and Cindy Regal.

The post-docs that I worked closely with at JILA were Simon Cornish and Elizabeth Donley. Simon was a very careful experimentalist who devised several ingenious tools to make our lives easier in the lab. He was fun to work with and he advanced the progress of the experiment immensely. I also had fun skiing with Simon and his wife. Elizabeth was a real inspiration for me. She provided a lot of energy to explore new research directions after Jake graduated and Simon returned to Britain. I was privileged to work with Liz and also to rock climb with her on several occasions. I acknowledge another post-doc, Servaas Kokkelmans, who help me greatly during the process of studying the weakly bound state of the Feshbach resonance. Servaas performed very intricate calculations to allow us to use our measurements of the molecular binding energy to constrain the Feshbach resonance parameters. He worked with Murray Holland to develop a theoretical model for our atom-molecule oscillation data. Servaas also cheerfully answered a huge number of my questions about the Feshbach resonance and scattering theory. I am very grateful for his friendship and help. Another post-doc that I would like to thank is Brian Anderson. I met Brian at DAMOP in 1998 and was thrilled to discover that he could image around 100 atoms in a BEC (we wanted to do similar

things with  $^{85}\text{Rb}$ ). After Brian came to JILA, he helped us out with some clever image processing tools and lots of helpful questions about our data. Brian was also a master hiker who helped me broaden my horizons for exploring the mountains around Boulder. Recently, I met Eleanor Hodby after she joined our experiment. Although I have not had the opportunity to work with her very much, I am very glad for the chance to know her. I can see that Eleanor is quite talented and will make many exciting discoveries with  $^{85}\text{Rb}$ . I should also acknowledge several other post-docs, including Eric Burt, who taught me to optimize the experiment “from soup to nuts”; Stefan Dürr, for his great physics knowledge and help with interpreting our results; David Hall, Simon Kuppens, Dwight Whittaker, and Peter Engels.

There were a large group of undergraduate students that I worked with during my time at JILA. Whether they were summer REU students or regular CU students, the undergrads performed a great deal of hard work for us. They built useful electronic circuits, analyzed data, and worked with diode lasers. I would like to acknowledge the people who worked in our lab: Carter Hand, Ryan Epstein, Jeff Collins, Nick Cizek, John Obrecht, Margaret Harris, and Alex Kane. I would also like to thank Estelle Andrews for her friendship and help with various projects.

It is hard to say enough about the JILA staff members. The fact that so many talented and bright people have chosen to work at JILA is a very large reason for the successful research that goes on here. I am thankful for the electronics shop staff, particularly Terry Brown, James Fung-a-Fat, Mike Whitmore, and David Tegart. The computing staff — in particular, Joel Frahm, Peter Ruprecht, and Jim McKown — have been indispensable. In addition, I want to thank several members of the instrument shop for their help: Blaine Horner, Hans Green, Seth Wieman, Hans Rohner, and Todd Asnicar.

I acknowledge my excellent undergraduate advisor, Keith Bonin, for encouraging me to pursue experimental physics. Keith was a wonderful person to work for. He always

had time to chat in his office about physics and many other interesting things. I really enjoyed working in the lab at Wake Forest — learning about diode lasers, atomic clusters, and basic machining. Keith found my passion for turkey hunting very entertaining and he actually made an effort to understand the basic principles. I really appreciate the advice Keith gave me about where to look for good experimental programs in AMO physics.

I also thank my good friends, the Swartz family. I have really enjoyed getting to know them during the past couple of years. Their children are truly wonderful and fun to hang out with. My parents and brothers have been very loving and supportive of my efforts in graduate school. I have been blessed to have such a close relationship with them, despite the fact that we live far apart. Finally, I want to thank my wife, Lisa Courtney. Lisa has supported me throughout my time here. She has been remarkably understanding of the long hours and occasional frustration that I felt. She encouraged me to do my best.

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