**General acknowledgements**

I would like to first thank my supervisor, Professor Natalia Korolkova, for her support and help over the past four years. My PhD has been fun, long, thrilling, difficult, enjoyable, frustrating, brilliant and always sinusoidal, and I am grateful to Natalia for her guidance and help in navigating each of these aspects. I should thank the many colleagues (and now friends) within the School of Physics and Astronomy who have contributed fun conversation and probing questions, and who have helped make the last four years so much fun. I have deeply appreciated these opportunities to grow in self-management and self-leadership, in scientific ability, in public speaking, in teaching, in writing, and in understanding and appreciation for our wonderful universe. Thank you to every undergraduate student I have taught or interacted with - you have reminded me that “yes I actually do quite enjoy physics, let me tell you why”. Thanks, Anton, for helping me understand Mathematica and Git. Thank you also to Hamish, to Jesús and to Cailean for giving me the privilege to work with you and explore fun aspects of quantum physics. I enjoyed it and I hope you did too.

I acknowledge deep support from my family. Thanks for listening to me trying to explain my research time and time again, and thanks especially to my parents for instilling in me a love and an appreciation for science and mathematics. I am grateful to Dad for convincing me to pursue physics (instead of Chemistry), and to both Mum and Dad for working so hard to support me financially through my first degree, and emotionally during this one. And thanks to my siblings Peter, Naomi, Annalise, Abigail and Andy for many years of friendship and encouragement.

I could not have survived without a little help from my friends. I am grateful, in particular, to those at St Andrews Baptist Church, who have put up with my potent combination of too-little-sleep and too-much-coffee for the last nine years. You have reminded me that there are bigger things to focus on and enjoy than the PhD, and more important places to find my self-worth and satisfaction than in my own productivity and scientific output. Thank you to Jesus for making (quantum) light in the first place. Thanks to everyone in the “Commune”. Thanks especially to James and Belinda, David, Daffyd, Jordan and Tamara, Emily, Gavin, the Milkman, the Irregulars, and so many more. I should say “thank you” to Andrew Rollinson for encouraging me towards a PhD in the first place (though he's probably forgotten about it) and say “hello” to Jason Isaacs.

Finally, I am deeply indebted for the love and support I have received from my wife Hannah. She has encouraged me when the PhD has just been plain annoying and rejoiced with me when it has just been plain brilliant. Thank you for allowing me to lock myself away to write for the last few months, and for being a source of fun, food and caffeine for the last few years.

**Funding**

This work was supported by the EPSRC [grant number 1798331].

**Research Data/Digital Outputs access statement**

Research data underpinning this thesis are available at <https://doi.org/10.17630/6ba10862-4bdd-478f-8bd7-4f4b4d383374>