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Application for a Galileo Circle Graduate Fellowship

I would like to apply for the Galileo Circle Graduate Fellowship. I am in my fourth year of studying for a PhD in the Lunar and Planetary Laboratory. I advanced to candidacy a year ago and have satisfied all the requirement for a PhD bar the final dissertation. I plan to graduate in the summer of 2003.

I come from Great Britain. After my junior year at college, I spent the summer working at the California Institute of Technology on an undergraduate research program. I liked America and I liked doing research. After my summer program ended, I spent a month travelling around the US visiting universities that I was considering applying to for graduate school. One of the places I visited was Tucson. I was impressed by LPL's research strengths and sheer breadth. 350 days of sunshine per year were also appealing to someone used to at least that many days of rain per year.

I moved to Tucson in the summer of 1998. I came with an undergraduate degree in Physics from Cambridge University and, like so many physicists, I was eager to apply my physics skills to other areas of science. Planetary science attracted me with the seemingly elementary level of so many of its important questions (why do we have a Moon, are there earthquakes on Mars, and so on), the chance to explore and understand the other planets in our solar system, and the opportunity to work in a field which generates immense public interest and excitement.

During my first few years as a PhD student, I worked on several different projects to develop the breadth of my knowledge. I do not wish to graduate as an expert in one tiny sub-discipline; I would rather have a good understanding of all the interdisciplinary branches of planetary science. I have presented research on the shapes of asteroids, on medieval chronicles talking of a large impact on the Moon, on simple models for planetary climate, on previously undiscovered ridges and folds on the surface of Mars, and on martian weather at major planetary science conferences.

I am currently trying to get the Mars Odyssey spacecraft into orbit around Mars safely and in one piece. My advisor, Steve Bougher, and I are working with engineers at NASA's Jet Propulsion Laboratory and scientists around the US on a daily basis as this sophisticated spacecraft makes regular passes through the upper atmosphere of Mars to lose speed (aerobrake) and reach its desired orbit without consuming all of its fuel

reserves. We try to predict what the state of the atmosphere will be like on each pass so that the spacecraft does not burn up like a meteor due to unexpectedly high densities and subsequent heating.

I plan to use my studies of the martian upper atmosphere as the main portion of my final thesis and supplement this with the many other projects I have worked on. After I graduate, hopefully in the summer of 2003, I intend to continue in an academic career in planetary science in the US or Europe. There are still so many questions that I yearn to answer about our solar system and about the new ones being discovered around other stars.

This fellowship would help my research by enabling me:

To continue investigating interesting ideas unrelated to my main research. I began my PhD studies afraid that I would not make the leap from solving problem sets to developing my own unanswered questions and striving to solve them. Thankfully, I soon had the opposite problem, that of having too many interesting ideas of my own that I wanted to investigate. I have been able to pursue some of those when my other responsibilities permit. Some of them have been failures, some have generated exciting results. I would like the intellectual freedom to continue chasing ideas and seeing where they lead.

To attend conferences that are not directly related to my main research. I have funded myself to attend several conferences in the past three years. Despite not presenting my main research there, I have learnt a great deal about current research in my field and established many professional relationships. I would like to continue to attend such conferences.

To relieve the burden on my advisor of having to spend much of his valuable time writing proposals to fund my existence. He has better things to do.

Yours,

Paul Withers

Curriculum Vitae for Paul Withers

4th year PhD student and Graduate Research Associate in the
Lunar and Planetary Laboratory of the University of Arizona

My main research topic at LPL is studying weather in the martian upper atmosphere by analyzing accelerometer data from the aerobraking of spacecraft orbiting Mars. Spacecraft targeting a tight, circular orbit around Mars spend their first few months in a loose, elliptical orbit which passes through the planet's upper atmosphere every few hours. This is much cheaper than burning rocket fuel to achieve the desired final orbit. Measuring the drag on the spacecraft with an accelerometer reveals the density of the atmosphere through which the spacecraft is flying. I have been involved with three such spacecraft, participating in regular discussions on how the changing weather on Mars will affect mission operations and making recommendations to the engineers flying the spacecraft. After this operational phase ends, I concentrate on scientific analysis of the data, trying to understand the changes in atmospheric density with latitude, season, and so on, and trying to better predict the variable densities that future spacecraft will experience. I try to be a Mars weather forecaster.

I have presented results from this research at several major scientific conferences. I have also worked on several other projects during my time at LPL and have published three peer-reviewed publications:

Withers and Neumann (2001) Tectonism in the Northern Plains of Mars, *Nature*, **410,** 651 [http://www.lpl.arizona.edu/~withers/pppp/pdf/molanature2001.pdf]

Withers (2001) Meteor Storm Evidence Against Recent Formation of Lunar Crater Giordano Bruno, *Meteoritics*, **36,** 525-529 [http://www.lpl.arizona.edu/~withers/pppp/pdf/mapsbruno2001.pdf]

Lorenz, Lunine, Withers, and McKay (2001) Titan, Mars and Earth: Entropy Production by Latitudinal Heat Transport, *Geophys. Res. Lett.*, **28,** 415-418 [http://www.lpl.arizona.edu/~withers/pppp/pdf/mepgrl2001.pdf]

I spent last summer working as a research consultant for the Beagle 2 Mars Lander project in Great Britain. I built on my aerobraking work to develop techniques to derive profiles of temperature, pressure, and density from accelerometer measurements during its atmospheric entry and landing in late 2003. This work gave me an insight into academic life in a very different environment from Tucson and may well provide a future job opportunity. My work will be at the heart of their measured temperature profile, only the fourth such measurement ever made on Mars.

Withers (2001) "You are required to assist on the Atmospheric Structure Reconstruction using the Beagle 2 Entry, Descent, and Landing Accelerometer", Final Report to the Planetary and Space Sciences Research Institute, The Open University, for Consultancy Contract 01249983\001 [http://www.lpl.arizona.edu/~withers/pppp/pdf/oureport.pdf]

I spent the summer before that working at NASA's Goddard Space Flight Center studying martian topography. I worked closely with the scientists who designed and built the MOLA instrument. This laser altimeter has measured the topography of Mars with better resolution than we have mapped our Earth. I saw how research scientists work in a non-university environment and was able to present my results at major scientific conferences and smaller, specialized meetings. My results from that project were published in *Nature* six months ago.

I have reviewed papers for *Science* and *Meteoritics*. I am a member of the American Geophysical Union's Planetary Sciences Section and the American Astronomical Society's Division for Planetary Sciences.

My writing skills have been acclaimed on two separate occasions. In 2000, I was highly commended in a science writing competition organized by a British national newspaper. In 1999, I won a worldwide NASA competition to name two spacecraft destined for Mars. My short essay was the best from over 17,000 entries.

My research has been highlighted by Lori Stiles of the UA news service on several occasions. My study of whether medieval witnesses saw a large meteorite impact the Moon (http://uanews.opi.arizona.edu/cgi-bin/WebObjects/UANews.woa/wa/MainStoryDetails?ArticleID=3561) broke their records for public feedback and interest. My work on martian topography (http://uanews.opi.arizona.edu/cgi-bin/WebObjects/UANews.woa/wa/MainStoryDetails?ArticleID=3439) was mentioned on CNN and by Discover magazine. Both these stories were featured by many websites and magazines specializing in news stories about astronomy and planetary exploration.

Academic Status

I have completed all my PhD requirements except the final dissertation.
I have received grades of A in all courses I have taken at University of Arizona. In two classes, the quality of my performance motivated the professors to write letters of commendation for my departmental file.

GRE Physics, 92nd percentile, and GRE General, over 97th percentile in all subjects
BA and MS in Physics, University of Cambridge, all grades First Class (equivalent of A)