TIDES IN THE MARTIAN ATMOSPHERE — AND OTHER TOPICS

by

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ACKNOWLEDGEMENTS

I came to LPL because everyone I met during my first visit here seemed friendly. Now that I'm ready to leave, I'm sure of it. The welcoming and relaxed environment pervading the department is something that's made my time here a happy one. The faculty, postdocs, and staff are always willing to spend their time, and everyone is willing to spend the faculty's money, encouraging the graduate students.

Hawthorne House has been my home for the past five years. I can't imagine LPL without it. As the host of Bratfests, Science Diet concerts, parties, Thanksgiving Dinners and innumerable gatherings of all sorts, it has been the centre of my social scene. I've shared it with many friends, including Kim Cyr, Joe Spitale, Rachel Mastrapa, Dave O'Brien, Laz Keszthelyi, Gareth Collins, Celinda Kelsey, Matt Chamberlain, Abby Wasserman/Sheffer, Jonathan Fortney, Eric Mamajek, and their lovers. Bratfest and its T-shirt industry have introduced me to absolutely everyone ever associated with LPL, trained me for my backup career in door-to-door sales, and thrown some damn fine fests. The Narcolepsy football team has kept me exercised and entertained. Christmas Skits and April Fools Pranks have cost me many hours of sleep and coincided with my worst day at LPL, but given me much laughter and a list of unprintable LPL pseudonyms. If the editing ever finishes before 6am, then I will know that the end is nigh. My officemates, Ross Beyer, Jen Grier, Ingrid Daubar, and Sally House, have given me office supplies and food. Many friends from other universities and the LPL alumni have made conferences less productive, but much more entertaining. Trading gossip with them has made the idea of leaving LPL less foreboding that it otherwise would be.

Fieldtrips have shown me and most of the Southwest's scenic gems and the true nature of many LPLers. Who can forget Day 4, Kring Narrows, Ralph ralphing, Pete covering himself in glory, Ross stranding us in Death Valley, Pete's stratigraphic monologue, Dave's glaciation speculation, spheroidal weathering, Alfred's vocabulary, or Jay's giant cracks?

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My tongue doesn't have the words to give the most important thanks to those who are always in my heart.

DEDICATION

With love and thanks

To family and friends

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ABSTRACT

The dynamics of the martian upper atmosphere are not well-understood. I have identified the dominant tidal modes present in the upper atmosphere by comparing density measurements from the aerobraking of the Mars Global Surveyor spacecraft to predictions from classical tidal theory. Other observations and general circulation models have also provided constraints. I have presented a justification for why topography has a strong influence on the tides in the upper atmosphere. I have also studied sol-to-sol variations in density at fixed altitude, latitude, longitude, season, and time of day. I have developed a novel "Balanced Arch" technique to derive pressures and temperature from these density measurements that also estimates the zonal wind speed in the atmosphere. These are the first measurements of winds in the martian upper atmosphere. This technique can also be applied to anticipated data from Titan to measure winds in its upper atmosphere.

I have developed techniques to derive density, pressure, and temperature profiles from entry accelerometer data, used them to investigate the entry of Mars Pathfinder, and discovered that surprisingly accurate temperature profiles can be derived without using any aerodynamic information at all. I have also investigated techniques to derive atmospheric properties from the Doppler shift in telemetry from a spacecraft during atmospheric entry and found that a surprisingly robust estimate of temperature at peak acceleration can be derived.

I have discovered a network of tectonic ridges in the otherwise bland northern plains of Mars and studied their implications for a possible ocean in that area.

I have tested the hypothesis that the formation of lunar crater Giordano Bruno was witnessed in 1178 AD and rejected it due to the lack of any observations of the immense meteor storm that must have followed the crater's formation.