Application to Graduate with Honors

Student ID: _____

I plan to defend in: FALL / (SPRING) of 2011

Personal Information:

Name: Paige Northway

Address: 3357 Stanford Ave
Boulder CO 80305

CU E-mail: paige.northway@colorado.edu

I am an: IN-STATE (OUT-OF-STATE) student

Academic Information:

☑ I plan to graduate with *Departmental Honors* in: Physics

☐ I plan to graduate with *General Honors*

Cumulative GPA:

Please attach a brief **PROSPECTUS**, **BIBLIOGRAPHY**, and **TIMELINE** of your thesis project to this application. When summarizing your work, consider the following:

- What is the problem you are investigating?
- What is the hypothesis you are testing?
- What is the focus of your study?
- What is your goal in this study?

Primary thesis advisor: Name: Tobin Munsat Dept: PHYS

List the other members of your committee:

Name: John Cumalat Dept: PHYS

Name: Scot Douglass Dept: HUEN

Name: _____ Dept: _____

Name: _____ Dept: _____

Departmental and General Honors Committee Checklist:

✓ Applicant has a total of at least three committee members.
✓ At least one Honors Council Representative is included on committee.
✓ At least one committee member from an outside department.

APPLICATION CONTINUED ON BACK OF THIS SHEET

Please initial if you are pursuing Departmental Honors:

PN I have consulted with my department and have completed (or am completing) the requirements they have established.

For Honors Council Representative:

I have met with applicant and approve him/her for departmental honors.

Printed Name: John P. Cumalat Signature: John P. Cumalat

Please initial if you are pursuing General Honors:

_____ I have completed (or am completing) the requirements for graduating with General Honors.
Please list the courses you have or are taking toward General Honors:

_____ _____

_____ _____

For General Honors Council Member:

I have met with applicant and approve him/her for general honors. I agree to be on his/her defense committee.

Printed Name: _____ Signature: _____

For the Thesis Advisor:

I have met with the applicant to discuss the proposed work and agree to provide the necessary help and direction for this thesis project.

Printed Name: TOBIN MUNSAT Signature: _____

For the Student:

I have read the requirements for graduating with honors at the University of Colorado. I also understand that my designation will be sent to the CU email address that I have provided and will not be given out over the phone.

Signature: _____ Date: _____

For additional graduation information including requirements, guidelines and deadlines, you can download them online at www.colorado.edu/honors

Prospectus: Focusing, Alignment and Particle Selection for a 3 MeV Dust Particle Accelerator

Paige Northway
Advisor: Tobin Munsat

The Colorado Center for Lunar Dust and Atmospheric Studies (CCLDAS), within the Laboratory for Atmospheric and Space Physics (LASP) and in coordination with the NASA Lunar Science Institute (NLSI), focuses on three main areas of research: dusty plasma processes at the moon's surface, environmental effects of human and robotic activities on the moon, and new instrument concepts for lunar exploration. The relevance of these subjects is derived from the lunar atmosphere being a Surface Bound Exosphere (SBE), which consists of approximately 100 molecules per cubic centimeter in comparison to the 100*1012 molecules per cubic centimeter of Earth's atmosphere. The constituents of the Moon's SBE emanate from a variety of sources, including solar wind, sputtering, micrometeoroid impacts , outgassing, and ionization. The atmosphere remains stable as molecules from these sources occasionally escape the exosphere or fall back to the surface. In the case of dust, macroscopic particles follow a ballistic trajectory whereas micron and submicron size particles are affected by electrostatic forces present on the moon's surface. Studying the lunar atmosphere will also provide insight on the atmospheres of Mercury, the rings of Saturn, icy satellites, large asteroids, and Kuiper Belt objects, which have similar SBEs.

A major part of this research will be conducted using facilities currently being constructed. These include a 3MeV micrometeoroid accelerator capable of accelerating particles of .2 to 2.5 μm in diameter up to velocities of 100 km/s. A beamline equipped with detectors capable of determining the velocity, charge, and mass of each particle and a selection unit to deflect particles not matching the requirements of a given experiment follows the accelerator. Additionally, interchangeable large and small test chambers are to be placed at the end of the beamline. The large chamber contains UV sources and a solar wind simulator in order to simulate the lunar surface, whereas the small (Ultra High Vacuum) test chamber is comprised of a rotatable target to be bombarded by micrometeoroids surrounded by detectors which will run microphysics diagnostics on the results of the impacts.

My work focuses on developing hardware to ensure that the dust particles traverse the beamline to the desired destination. The first step of this occurs before the accelerator in the form of electrostatic lensing to focus the trajectory of the particles through the beam line to a small spot size in the center of the target. Simulations run in the ion optics simulation program, Simlon®, determined the optimal geometry and settings for the electrodes of an Einzel lens used and, according to simulation, a distribution of particles can be focused to a spot size of .5 mm at the position of the target. To place the target at the point at which the particles are focused, I have created a laser alignment system, which incorporates a laser and a retractable 45° mirror to indicate the point on the target where the particles should impact while a new target is being placed inside the end of the beamline. In the event that the particles are not following the expected path, I am also developing a removable beam position detector modeled after the Dust Trajectory Sensor (DTS) Jianfeng Xie is working on. This detector will give a rough X-Y position of particles in the beamline, indicating whether the beam is centered in the beamline. The position of the beam can be corrected by X-Y steering plates. Finally, experiments of similar nature at the Max Plank Institute for Nuclear Physics in Heidelberg, Germany have shown that it is possible for a particle to lose its charge after being accelerated, thus rendering it invisible to all the detectors but still allowing it to impact the target. I have been running simulations to investigate the possibility of electrostaticly bending the trajectory of the particles in order to prevent these undetectable particles from striking the target.

Timeline

August/September 2010:
Design particle position detector and laser alignment system

October 2010:
Finalize design for particle position detector and begin building; also finalize design for laser alignment

November 2010:
Build final parts for the laser alignment and begin setting it up; continue work on particle position detector

December 2010/January 2011:
Finish work on both laser alignment system and particle position detector; write background section of thesis

February 2011:
Run any necessary tests on both systems; begin filling in details of thesis; determine any numbers/simulations/tests that I still need

March 2011:
Do any final SimIon simulations; finish writing thesis

April 2011:
Defend thesis

Bibliography

J.B. Bradley, E. Gruen, R. Srama. The cosmic dust analyzer for Cassini. SPIE Proc. 2803, 108–117, 1996.

M. Stubig, G. Schafer, T.M. Ho, R. Srama, E. Gruen, Laboratory simulation improvements for hypervelocity micrometeorite impacts with a new dust particle source. Planetary and Space Science, Volume 49, Issue 8, pp. 853-858, 2001.

S. Auer, E. Grün, S. Kempf, R. Srama, A. Srowig,
Z. Sternovsky, and V. Tschernjawski. Characteristics of a dust trajectory sensor. Review of Scientific Instruments, 79, 084501, 2008.

Hellborg, Ragnnar. Electrostatic Accelerators. Berlin Heidelberg: Springer-Verlag, 2005.