POSTER SESSION 3

Commons East, Easel 68

2:30 PM to 4:00 PM

Ice Crater Analysis Using Advanced Surveying Techniques

Logan Schuyler Guillet, Senior, Earth and Space Sciences: Geology
Mentor: Mariah Danner, Earth and Space Sciences
Mentor: Robert Winglee, Earth And Space Sciences

This research focuses on using advanced surveying techniques as well as hand mapping to analyze force distribution during laboratory impacts of man-made projectiles into ice. This is done in the hopes of characterizing substrate damage surrounding an impact crater created by a proposed hard landing system. Knowing where these different deformation zones occur is useful in determining where the lander could sample. The landing system, the Subsurface Ice Plume Sampler (SIPS) utilizes ejecta (broken up debris thrown from the crater) to create a transient atmosphere - decelerating a secondary instrument package through momentum transfer. Small-scale experiments were done on one-ton buckets of ice using scale-sized projectiles. Between two hundred and five hundred images used to 3D models of the ice craters using the structure from motion imaging technique. Hand mapping of the deformation zones (areas of different types of fractures) was conducted to compare to the 3D model to help show the directionality of force distributions through the crater. Using both the 3D models and a hand mapping analysis of the craters, we were able to determine that the crater shapes were atypical. In a typical crater, the force disperses radially outward from the impactor; however, we determined that the majority of the force was focalized directly below the impactor. Future work includes using Rhinoceros 3D computer software to quantitatively analyze each crater's individual morphology, curvature, and volume and compare them to traditional impact craters.

POSTER SESSION 4

Commons East, Easel 68

4:00 PM to 6:00 PM

A Numerical Modeling Approach to Analyzing Man-Made Impact Craters

Callum Joseph Farrell, Senior, Physics: Comprehensive Physics
Mentor: Robert Winglee, Earth And Space Sciences
Mentor: Mariah Danner, Earth and Space Sciences

The computational modeling aspect of the Kinematics and Impacts Lab seeks to create accurate models and predictions of ice/penetrator interactions during high velocity collisions of the proposed Subsurface Ice and Plume Sampler (SIPS) lander. These penetrator collisions create a collumized plume of ejecta (ice shards and water vapor) that can be used to land an instrument package. Using the data from the models, the ice penetrator design is streamlined. The models are created using ANSYS's Autodyn software, a hydrocode designed to simulate large material deformations. Generally, the models we create describe the impact of a small, hollow, cylindrical projectile traveling at 1 km/s impacting a stationary block of ice, which necessarily results in severe loading and large deformation as the surface of the ice is pulverized by the impact. Accurate representations of this "pulverization" are desirable for several reasons. First, we would like to know what happens physically to the projectile (depth and deformation for example). Second, we would like to understand how the projectile's deformation during impact influences the properties of the ejecta produced. Understanding the behavior of the ejecta is an essential part of the modeling - this ejecta plume and it's geometry are necessary for successful landing of the instrument package. A model that accurately describes the impact process is invaluable, as it allows easy analysis of different projectile designs and impact velocities at different scales without conducting expensive and time-consuming experiments. Once the plume interaction is properly constrained using ANSYS, future work will focus on more accurately modeling the crater morphology using a separate numerical modeling program, iSale.

POSTER SESSION 4

Commons East, Easel 67

4:00 PM to 6:00 PM

Designing a Reliable Asteroid Sample Retrieval System

Connor Geiman, Senior, Mechanical Engineering
Kenneth G (Ken) Aragon, Junior, Pre Engineering
UW Honors Program
Mentor: Robert Winglee, Earth And Space Sciences
Mentor: Mariah Danner, Earth and Space Sciences

Asteroid sample return has potential to impact research and how humans collect resources, but sample return missions remain prohibitively expensive and complex. We propose a device to retrieve a preexisting sample container from the surface of an asteroid or other extraterrestrial body, focusing on simplicity, repeatability, and reliability. Taking inspiration from a classical design, the bear trap, we created a functional 3D printed prototype, which is mechanical and capable of capturing a 1.5x15 in cylinder resting on a flat surface. Consideration was given to potential rocky terrain or an awkwardly positioned return container, and to sealing the sample container to prevent contamination upon return to earth. Future prototypes will be constructed from stronger, lighter weight materials and will be further developed during active field tests on debris at a penetrator impact site in Eastern Washington.

POSTER SESSION 4

Commons East, Easel 66

4:00 PM to 6:00 PM

Buildup of Large Scale Field Test for Asteroid Sampler

Joshua Hae Soo (Josh) Lee, Senior, Earth & Space Sciences (Physics)
Marcquis De Shawn Harris, Senior, Astronomy, Physics: Comprehensive Physics
Dominic C. (Nick O.) Ongoco, Senior, Earth & Space Sciences (Physics)
Mentor: Robert Winglee, Earth And Space Sciences
Mentor: Mariah Danner, Earth and Space Sciences

Our current research with the Kinematics and Impacts Lab at the University of Washington entails the design, buildup, and field testing of an asteroid sampling system. These field tests include the buildup of two stage closer rockets, which are highlighted in this presentation. This asteroid sampler field testing helps characterize the sampling process of impacting an asteroid at high speeds- necessitating our rocket system be capable of stable, high speed flight, even at an inverted trajectory. The booster stage, or primary stage, of the system consists of a single large motor to allow the system to reach between 3000-4000 feet above the ground. The sustainer, or second stage, consists of eight smaller motors clustered around a central body tube, allowing the second stage to be hollow. Finally, a hollow point steel nose cone caps the sustainer. Inside the nose come assembly a sample dive is attached, designed to eject during impact. Field testing of this system occurred in December 2018, with preliminary results being compiled.

POSTER SESSION 4

Commons East, Easel 65

4:00 PM to 6:00 PM

Computer Modeling of Europa Rocket Penetrator Ice Impacts

Eric Jordan Racadag, Senior, Aeronautics & Astronautics
Kavic Raman Kumar, Senior, Aeronautics & Astronautics, Physics: Comprehensive Physics
McNair Scholar
Mentor: Robert Winglee, Earth And Space Sciences
Mentor: Mariah Danner, Earth and Space Sciences

This purpose of this project was to investigate the impact of a rocket penetrator for sample-return missions focused on Jupiter's icy moon, Europa. In particular, primary analysis used the kinetic energy from the ejecta plume of the impact crater to halt the momentum of the primary payload to model the impact. To do so, steel alloy projectile impacts in a material with properties of ice (so as to simulate the surface of Europa) were simulated using ANSYS Autodyn computational dynamics software. ANSYS Autodyn makes use of both Lagrangian and Hamiltonian meshes, as well as smooth particle hydrodynamic mesh-less modeling with cross-coupling so as to best represent the impact of the projectile, the material deformation, and the projectile deformation. This analysis of elastic and plastic behavior, as well as bulk failure and separation, resulted in accurate depictions of deformation in both the projectile and target material, validating it as a model with the potential to simulate the impact of a Europa sample-return rocket penetrator. This analysis serves as a basis for future progress, and will soon be enhanced via further simulation in conjunction with ISAIL simulations so as to accurately depict the material deformation and ejecta plume. The data from these computer simulations can eventually be compared to physical experiments and field tests that are to be conducted under the University of Washington's Kinematics and Impacts Laboratory (KILa).