Poster Session 1

Commons West, Easel 23

11:00 AM to 1:00 PM

Low Mars Orbit Air Breathing Ion Thruster Concept

Ryan Westerdahl, Senior, Aeronautics & Astronautics
NASA Space Grant Scholar
Nicholas James (Nick) Harvey, Senior, Aeronautics & Astronautics
Brandon Hu, Senior, Aeronautics & Astronautics
Robert Dyer, Junior, Aeronautics & Astronautics
Mentor: Setthivoine You, Aeronautics & Astronautics

Ion thrusters have a wide range of applications because of the small amount of fuel needed in order to make large delta-V maneuvers. One possible ion thruster concept is for use in the upper Martian atmosphere which is comprised of mainly CO_2. At lower orbits where the atmosphere is still faintly present, an ion thruster could be used to provide constant thrust, and keep a low orbiting satellite in this orbit for an extended duration without the satellite falling due to the drag caused by the upper Martian atmosphere. The research being presented is on an air breathing low mars orbit electrostatic ion thruster concept that uses trace amounts of CO_2 in the upper Martian atmosphere as the plasma fuel source. Our team has designed, built and tested an ion thruster testing this concept. The ion thruster has a cylindrical chamber with an inner chamber diameter of 4.8 inches. The plasma is created by ionizing CO_2 gas with emitted electrons from a tungsten filament cathode in a 12 inch diameter vacuum chamber. A two screen electrostatic grid is used to control the plasma and accelerate ions in order to produce thrust. The ion beam is neutralized using another tungsten filament cathode. Four separate power supplies were used in order to create the plasma, supply voltage to the electrostatic grids, neutralize the ion beam, and create the axial magnetic field that controls the electrons inside the thruster. The high velocity ions that are generated by the thruster are emitted in a controlled fashion that then produces thrust. This thrust was calculated by using the measured power going to the neutralizer cathode, and the particle exhaust velocity. The exhaust velocity was calculated from the separation between grids, and the potential difference applied across the grids.

Poster Session 1

Commons West, Easel 14

11:00 AM to 1:00 PM

Electron Density Fluctuations within the HIT-SI Experiment

Taylor Keith (Taylor) Fryett, Senior, Physics
UW Honors Program, Undergraduate Research Conference Travel Awardee
Mentor: Thomas Jarboe, Aeronautics & Astronautics
Mentor: Brian Victor, Aeronautics and Astronautics

This research traces the origins of electron density fluctuations in the HIT-SI experiment. HIT-SI is a magnetic confinement experiment that uses two helicity injectors to initialize and sustain current in the confinement region. Densities of 1-10e19 $m^{-}3$ with density fluctuations related to the injector frequency are measured with an FIR interferometer. After spheromak formation, injector currents flow in the direction of toroidal current in the confinement volume. Peaks in the density fluctuations are seen when the injector current passes through the beam path of the interferometer. These observations are consistent with particle motion in the direction of injector current as expected by anti-dynamo action in this region. Furthermore, we have observed fluctuations that indicate that the injector current displaces the confined current. Calculating the toroidal current centroid from surface magnetic probe measurements as a function of time provides further testing of this model. Understanding density fluctuations allows a more complete description of the physics of current drive in HIT-SI.

Poster Session 1

Commons West, Easel 25

11:00 AM to 1:00 PM

Investigation of Neutron Emission from a Farnsworth IEC Fusion Reactor

Raymond Aung (Raymond) Maung, Junior, Physics: Comprehensive Physics
Rian Naveen (Rian) Chandra, Sophomore, Pre-Sciences
NASA Space Grant Scholar, UW Honors Program
Mentor: Brian Victor, Aeronautics and Astronautics

The Farnsworth-type IEC reactor was once considered to behave as a point source of neutrons with reference to the spher-

ical central accelerating grid. This was assumed because the deuteron-deuteron fusion reaction is inherently spherically symmetric (isotropic), and current theory suggested that the vast majority of fusion events were occurring in the deepest region of the potential well (the accelerating grid, which is also the geometric center of the reactor). However, anecdotal evidence has suggested that isotropy may not be empirically accurate. Our main objective was to conclusively test the assumption by measuring deviations from uniformity in the neutron flux. To measure this we used three different types of detector: CR39 plastic, BTI bubble detectors and He-3 dosimeters. We exposed the CR39 slides to fast neutrons (2.45 MeV) at a fluence of 10ˆ6 n/cmˆ2, and they indicated apparent anisotropy (p-value of .0035) with higher flux at the front and rear of the machine. The BTI bubble detectors and He-3 tubes also corroborated a higher neutron density at those sites. We then hypothesized that beam loading on the front and rear conflats by the plasma "jets" emanating from the central cathode could be responsible. Measurements with paired He-3 tubes after blocking the jets with quartz glass showed the apparent anisotropy reduced by 38% on average ($p << .001$). This quantitative confirmation of anisotropy, and the significant (but not sole) role that beam-target fusion plays therein, represents an important shift in the understanding of the Farnsworth-type reactor, which could have important implications in plasma physics and the development of fusion energy.

SESSION 2J

NEW SCIENCE FROM A TO Z

Session Moderator: John Berg, Chemical Engineering
271 MGH
3:30 PM to 5:00 PM

* Note: Titles in order of presentation.

Spectroscopy Analysis of Z-Axial Pinch Plasmas
David J. (David) Goldstone, Sophomore, Pre-Major (Arts & Sciences)
Mentor: Uri Shumlak, Aeronautics & Astronautics

Plasma, the fourth state of matter, makes up over 99% of the visible universe. However, plasmas have so far found few applications, the most notable of which include fluorescent lights, fusion energy, and space propulsion. Plasma researchers believe that the scarcity of plasma applications is due to the difficulty in controlling plasmas; therefore, obtaining a true control of high temperature, high density plasmas will likely spur on a plethora of new plasma applications. At the University of Washington, the ZaP Flow Z-Pinch Experiment is one of many research labs studying high desnity plasmas in order to both create and aid the development of plasma applications. This presentation will include both a discussion of the problems confronting the development of plasma applications and an overview of the presenter's work in developing spectroscopy analysis–the analysis of light spectra emitted by impurity ions in the ZaP experiment to determine the characteristics of controlled plasmas–as a primary tool towards obtaining an understanding of plasmas that promotes innovation.

POSTER SESSION 3

MGH 241, Easel 170
2:30 PM to 4:00 PM

Simpler, Safer and "Greener" Liquid Propellant Rockets for Applications in Research
Thomas Joshua (Thomas) Kraft, Senior, Aeronautics & Astronautics
Mentor: Adam Bruckner, Aeronautics & Astronautics

Liquid bipropellant rockets have numerous benefits in performance and safety compared to other chemical rockets, yet their propellants are often too toxic and difficult to handle for most researchers to utilize. Additionally, these rockets are often complex in design, increasing their cost and further discouraging their use. This research project is intended to help find a solution to these challenges by designing and testing a rocket engine that uses safer, environmentally-friendly propellants and a simplified injection design. A prototype rocket has been built and is in the process of being tested on a static test stand. Multiple propellant combinations are being researched to retrieve data on combustion temperature, combustion stability, and specific impulse (thrust per unit mass flow of propellant). The results will be used to determine which propellant combination is the most promising candidate for further research, eventually leading to a design for a simple liquid bipropellant engine for use by universities.