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Abstract

The focal purpose of the Voyager Interstellar Mission has been to broaden the NASA exploration of the solar system further than the quarter of the outer planets and extend to the limits of the sphere of influence on the sun and even beyond. This expansive mission has been continued to characterize the environment of the outer solar system and has also assisted in search for heliopause boundary i. e. the outward flow of solar wind and the outer limits of solar magnetic field. Heliopause boundary penetration between the interstellar medium and the solar wind allows in measuring interstellar fields, waves, and particles that are unaffected by the solar winds.

Arguably, it is apposite to think about VIM in three separate phase; the interstellar exploration phase, the heliosheath, and the terminal shock. The two Voyager spacecraft started with the VIM operating, they are still in operation in an environment that is controlled by the solar magnetic field that has plasma particle controlled by those in the escalating supersonic solar wind. As explained in this paper, the termination shock phase is explained by this distinctive environment.

Finally, this work elaborates of the number of challenges that has constantly constrained the success of VIM i. e. the distance between earth and space that result from increased time of the spaceship to arrive at their destination, and presence of objects and particles in the space which bring about resistance of the spaceship.

Voyager Interstellar Mission (VIM)

1. 0 Introduction

Since time immemorial, humankind has always strived to discover and visit various planetary systems. This has seen them discover rockets and initiate various missions to aid in this discovery. Voyager missions represent one of the hardest discoveries that have been put in place in a move to understand the universe and planetary systems. Voyages 1 and 2 were launched in 1977 while Voyager Interstellar Mission (VIM) was launched in 1989 to understand the composition within these planetary systems. This essay seeks to explore the history of the voyager missions, the VIM programme as well as the team behind VIM and the role they served in the program.

2. 0 History of the Voyager mission

The history of the voyager mission dates back to the late 1970s and early 1980s. The official approval of the voyager mission was done in May 1972, with an aim of providing knowledge and information on the outer planets. The missions sought to take advantage of the rare four-planet tour geometric arrangement, whereby the spacecraft would swing from one planet to another with minimal propulsion system. This arrangement aids the spacecrafts to move easily between Jupiter, Saturn, Uranus and Neptune, with the gravity of each planet facilitating the spacecraft to gain enough velocity to get from one planet to the other. Traditionally, a four-planet mission would be extremely expensive to conduct since it would demand the construction of a specialized spacecraft that would carry heavy equipment for long hours to traverse through the four planets (Gray). However, with rare geometric arrangement that occurs once in every 175 years reduced the cost of conducting the four-planets mission since it took advantage of gravity from one planet to another.

The first voyager mission (voyager 1) was first initiated to enhance study of planet Jupiter and Saturn only. The process began with studying and choosing the most ideal trajectory for the mission. Over 10, 000 courses were studied, and the scientists narrowed down to two that would provide clear information of Jupiter and Saturn as well as their largest moons Io and Titan respectively. The first mission also explored the ideal path for the second voyager mission (voyager 2) that would explore Uranus and Neptune planets. Voyager 2 was the first to be launched in august 20, 1977 at the NASA Space Center, Florida while Voyager 1 was launched later in September 5, 1977 using a relatively shorter and faster route. Expandable rockets were used in the launching process (JPL 125).

Voyager 1 route was designed in such a way that it would send spacecraft closely past Titanic and behind the Saturn's rings. The geometric arrangement would then inescapably send the spacecraft out of the ecliptic plane that most planets use to orbit the sun. Voyager 1 encountered Jupiter on 5th March 1979 and Saturn on 12th November 1980. On the other hand, Voyager 2 flew past Saturn and was inevitably diverted to Uranus. The voyager encountered Jupiter on 9th July 1979 and Saturn on 25th August 1981 (JPL 130). After Voyager 2 encountered Saturn successfully, NASA provided further funding for the mission for it to continue.

Voyager 1 pressed further outwards towards the heliopause space that marks the end of the sun's magnetic influence and beginning of the interstellar space. According to Gray, Voyager 1 crossed the heliosheath and is moving outside the solar system over the ecliptic plane at an estimated speed of 520 million km/year. The voyager entered the interstellar space on 25th August 2012. On the other hand, Voyager 2 continued to provide comprehensive information on Uranus and Neptune using photos and various forms of data that revealed the magnetic fields, rings and other crucial information on the two planets (voyager. jpl. nasa. gov). Voyager 2 also headed outside the solar system at an estimated speed of 470 million km/year. Kohlhase (91) notes that the two spacecrafts are continually providing information on ultraviolet sources from the stars, particles and fields in the space. The two voyagers are expected to supply this information and communications for about one more decade. It is estimated that the communication will be broken down when the power sources can no longer power the subsystems and equipment within the spacecrafts.

3. 0 Voyager Interstellar Mission (VIM)

The VIM was launched in 1989, with an objective of extending the exploration of the solar system. It created an ideal opportunity for scientists to learn more about the interstellar space. According to Ludwig & Taylor (2) the interstellar space is composed of the interstellar medium, that is gas, dust, assortment of charged particles and magnetic fields. An estimated 99% of the interstellar medium is gas while the rest of the matter is largely dust. The gas content is also largely hydrogen, which composes of 90% of the gas while the remaining gas is largely helium. As such, the VIM played a crucial role in understanding this composition and other information about this space.

The VIM’s main objective was to extend the voyagers mission beyond the four planets to explore interstellar space, neighboring planets, the outer limits of the sun’s sphere and the space beyond. The VIM also sought to establish the heliopause boundary as well as define the sun’s magnetic field and how the solar winds flow outwardly (Richardson). The VIM also aimed at penetrating the space between solar winds and the interstellar medium to determine interstellar fields, waves and particles of the solar wind.

The VIM has various distinctive characteristics. Notably, the mission sought to extend voyager 1 and 2 whose mission was terminated in 1989 when it was launched. VIM has three distinct phases. These are the terminal shock, heliosheath exploration and interstellar exploration phases.

According to NASA (5) the terminal shock phase is characterized by the two initial voyager's operations in the sun's magnetic field. This field is characterized by supersonic wind that dominates the plasma particles. The interstellar winds hold the supersonic solar winds from expanding beyond their limits. At the terminal shock phase, the slow wind reduces its velocity from supersonic speed to subsonic speed. Further, the magnetic field orientation and changes in the direction of plasma flow takes place during this phase.

The termination shock phase paved way for the heliosheath exploration phase. The phase is dominated by the solar wind's particles and sun's magnetic field. This phase will be terminated when VIM passes the outer frontier of the solar wind and sun's magnetic field (heliopause). Scientific researchers have indicated that no spacecraft has ever reached the heliopause region. According to Gray, it is estimated that the region might be between 8 and 14 billion miles from the solar, and the solar winds blows at an estimated 250, 000 miles per hour. It is further estimated that the VIM will cross the heliopause region in between 10 and 20 years time (NASA 7). This process may take several astronomical units for VIM to traverse the heliopause. The complete passing of this phase will characterize the beginning of the interstellar exploration phase, which is the main goal of VIM.

3. 1 VIM Teams and their roles

Currently, there are five investigations teams within VIM. These teams are responsible maintaining spacecrafts, collecting the data, processing and analyzing the data and later presenting it to the public. These teams utilizes highly specialized equipment and tools to rely this information from space to the public. These include the spacecrafts that are travel freely in the space gathering this information and data. The information acquired is then transmitted to the ground stations located at the NASA Deep Space Network (DSN) where a team of specialized personnel analyses, documents and shares it with the public. The DSN centre provides a two way communication between the space and ground to facilitate information transfer (voyager. jpl. nasa. gov). Some of the key equipment used in the process includes the transmitters, receivers, antennas, amplifiers and monitoring and control systems and subsystems. These equipments work in tandem to show diverse information ranging from the magnetic fields, energy spectra of solar wind particles and interstellar cosmic rays, distribution of hydrogen and helium in space and the strength of the radio emission that emitted from the heliopause. In order to capture and analyse this data, there are five specialized teams within the VIM system. These are:-

- Magnetic field investigation
- Low energy charged particle investigation
- Cosmic ray investigation
- Plasma Investigation
- Plasma wave investigation

The teams have specialized knowledge and expertise, and the use specialized equipment to capture the relayed information. The teams have principal investigators who lead in the process as well as co investigators who facilitate in the process.

3. 1. 1 Magnetic Field investigation

The magnetic field investigation team uses the magnetic fields, waves and particle sensors. These scientific sensors work in tandem with various scientific subsystems to relay this information. The magnetic field investigation team plays a key role in maintaining these systems and their subsystems in space to ensure that the right quality and quantity of information and data is transmitted (Gray). The team is also responsible for analyzing the magnetic data acquired that ranges from magnetic fields and particles.

In order to realize its mission, the magnetic field investigation team uses an assortment of magnetic field investigation equipment and tools. This equipment has revealed the presence of magnetic fields, waves and particles in the four planets (Jupiter, Saturn, Neptune and Uranus) although with varying strength and wavelengths.

3. 1. 2 Plasma investigation

The plasma investigation team is responsible for determining the macroscopic components of the plasma ions as well as the value of the velocity, pressure and density of the plasma ions. Some of the equipment used during this process includes two faraday cup detectors mounted on the spacecraft. The equipment is also designed in a way that they can cover both subsonic and supersonic flow of the space winds. The plasma spectrometer (PLS) is also highly used by this team to investigate the macroscopic properties of the plasma ions. The equipment measures the energy of electrons that range between 5 eV and 1 keV (Kohlhase 96).

The plasma investigation team comprises of individuals with specialization in planetary sciences, fields and particles investigations, space physics as well as heliospheric studies. Some of the team members include Dr. John D. Richardson who is the team`s principle investigator. Under him, there are over eleven co-investigators, who include Dr. Keith Ogilvie from NASA, Prof George Sisco from the University of California, Dr Arthur Hundhausen from the National Center for Atmospheric Research and Dr James Sullivan who is affiliated to the Massachusetts Institute of Technology (JPL 150).

3. 1. 3 Plasma wave investigation teams

The plasma wave investigation team is responsible for measuring the density of electrons as well as providing information on the wave interaction. The investigation team also reveals information on interstellar magnetospheres. To carry out these activities, the plasma wave investigation team uses an assortment of receivers such as the step-frequency receiver and low frequency waveform receivers. These receivers are equipped with antennas and diverse electronics.

The teams are specialized in planetary sciences, heliospheric sciences and space physics. The team is led by Prof. Donald Gurnett who is the principal investigator. Prof Donald is affiliated with the University of Iowa (Morrison 239).

3. 1. 4 Cosmic ray investigation

The cosmic ray investigation team is responsible for investigating the origin and acceleration of the interstellar cosmic rays. Further, the team researches on dynamics, history and behavioral traits of the cosmic rays. The team further researchers on the nucleosynthesis elements in the cosmic ray sources and planetary energetic particles. In order to receive, analyze and present this data, the cosmic ray investigation team uses sophisticated tools and equipment, including the low energy telescope system (LETS) and the high energy telescope system (HETS). The HETS is used to cover nuclei energy range of between 6 and 500 MeV. The equipment also measures the interstellar cosmic rays with energy range of 0. 15 and 30 MeV and atomic numbers within 1-30 range. Lastly, the cosmic ray investigation team also uses this state-of-art equipment to measure electrons with energy that ranges between 3 and 100 MeV per nucleon (NASA 7).

The cosmic ray investigation team is comprised of highly qualified and specialized personnel drawn from astronomy, planetary science, heliospheris and space physics disciplines. The principal investigator within the cosmic ray investigation team is Prof Edward Stone, who leads around co investigator. They include Dr. AloisSchardt from NASA, Dr James Trainor from NASA, Prof William Webber from the University of New Hampshire and Dr. Frank McDonald from the University of Maryland (Morrison 240).

3. 1. 5 Low Energy Charged Particle investigation team

The low energy charged particles investigation team is charged with the responsibility of measuring energy fluxes, as well as the distributions of ions, electrons energy ion composition. In addition, this investigation team analysis the energy particles in both planetary and interplanetary environments. According to JPL (258) the energy particles in the planetary environment are analyzed using the various low energy detectors. The detectors conduct both single and coincidental data counts to analyze the energy charged particles. In the planetary mode, the low energy telescopes were used to identify the protons and low energy particles. These sets of equipment measures energy range of between 10keV and 11meV for the electrons within and outside interstellar space and 15keV ans 150Mev for the protons and ions within the similar space (Richardson).

The Low Energy Charged Particle investigation team comprises of specialists in planetary science, space science and heliospheric studies. The principle investigator is Dr. StamatiosKrimigis from the Applied Physics Laboratory. Under him, there are about 8 co investigators who assist in the data collection, analysis, documentation and sharing (Kohlhase 100). They include Dr. Carl Bostrom from the Applied Physics Laboratory, Dr. William Axford from the Victoria University, Dr Charles Fan from the University of Arizona and Dr Edwin Keath from the Applied Physics Laboratory.

4. 0 Challenges facing VIM

Oblivious of the major exploration milestone that have been realized by the VIM, there still exist a number of challenges that are hindering realization of the full potential in this mission. One of the outstanding challenges is the huge distances between the earth and space. The spaceships are compelled to travel for long distances from the earth to the space to acquire the desired information and relay it to the ground. Further, the mission requires sufficient amount of time to fulfill its mission due to the distance between the ground and space as well as the distance between different planets. Secondly, the numerous obstacles in the space also pose a challenge to the spacecrafts. The solar system is composed of gases, asteroid belt, comets and free asteroids among other that resists the smooth flow of the spacecrafts (NASA 4). As such, any object sent from the ground has a high chance of hitting an object in the interplanetary and interstellar space, which can ultimately lead to a failed mission. The resistance posed by these objects has further extended the time taken by the spacecrafts to get to their destination.

The last obstacle that VIM has encountered is the power sharing issue. The VIM used spaceships where various objects and equipments were mounted, and they were supposed to share the available power to function effectively. However, it is impossible to recharge the spacecrafts to ensure that power is constantly supplied to different equipment within the spacecraft. As such, the available power can only support few instruments at any given time; thus, only a given set of data and information can be acquired at any given time. Ultimately, the VIM team suggests that when power can no longer support any equipment within the VIM, the mission will be aborted (voyager. jpl. nasa. gov). This will be a terrible eventuality noting the role that VIM has played in supplying data and information on space.

5. 0 Conclusion

It is indubitable that the VIM remains as one of the landmarks in the history of the study of planetary systems. The VIM played the role of extending Voyager 1 and Voyager 2's mission in the space (Gray). The mission aided in studying different planets and their characteristics. To facilitate in the process, the mission has a number of specialized teams who uses specialized equipments to acquire various data and information.

These are the magnetic field investigation team that acquires data on the magnetic field, waves and particles in different planets. The low energy charged particles investigation team is responsible for analyzing the differential energy fluxes as well as distribution of ions, electrons and energy ion composition. In addition, this investigation team analysis the energy particles in both planetary and interplanetary environments. The cosmic ray investigation team is charged with the role of investigating the origin, behavior and acceleration of the interstellar cosmic rays. Further, the team researches on the nucleosynthesis elements in the cosmic ray sources and planetary energetic particles. The plasma investigation team determines the macroscopic components of the plasma ions as well as the value of the velocity, pressure and density of the plasma ions. Lastly, the plasma wave investigation team is responsible for measuring the density of electrons as well as providing information on the wave interaction. The investigation team also reveals information on interstellar magnetospheres.

There have been a number of challenges constraining the success of the VIM. These include huge distances between the earth and space, resulting into increased time of the spaceships to reach their destination. Secondly, presence of objects and particles in the space has increased the resistance of the spaceship, thus extending the travel time. Lastly, lack of adequate power to hold the equipments in the space is also a major challenge to the mission.

References

- Gray, Meghan. Voyager and Interstellar Space. Deep Space Videos. Brady Haran.

Interstellar Mission: Voyager, the Interstellar Mission. 2013. 11 Nov. 2013. http://voyager. jpl. nasa. gov/mission/interstellar. html

- Jet Propulsion Laboratory - JPL. Voyager Neptune/Interstellar Mission: Flight Science Office Science and Mission Systems Handbook. JPL Project Document 618-128, Jet Propulsion Laboratory, Pasadena, CA, 1987: 120-160

- Kohlhase, Charles. The Voyager Neptune Travel Guide. Pasadena, CA: JPL Publication, 1989: 90-100.

- Ludwig, Roger & Taylor, Jim. Voyager Telecommunications. California:

California Institute of Technology, 2012: 1-10.

- McNutt, R. L., Jr., et al., Positive ion observations in the middle magnetosphere of Jupiter, J. eophys. Res., 86, No. A10, Sept. 1981: 8319-8342.

- Morrison, D., Voyages to Saturn, NASA: National Aeronautics and Space Administration, Washington, DC, 1982: 234-240.

- National Aeronautics and Space Administration – NASA. Voyager to the Outer Planets andInto Interstellar Space. California: California Institute of Technology. 2013: 1-7

- Richardson, John. Voyager Interstellar Mission. 2013. 10 Nov. 2013. http://web. mit. edu/space/www/voyager_science. html

- Voyager Time Line: Voyager, the Interstellar Mission. 2013. 10 Nov 2013 http://voyager. jpl. nasa. gov/mission/interstellar. html