Space Observatory to Study Black Holes

Jayapoornima.V, Vaishali.K
B-TECH, ECE, SRM Institute of Science and Technology
Plot 59/1, Main road, ThirupathiThangavel Nagar, PonniammanMedu, Chennia-600099, India

Abstract

This article explains about the study ofBlack holes with the help of a space observatory called theImaging X-ray Polarimeter Observer (IXPE). It isoriginally designed and constructed by the NASA space mission team and it is planned to be launched by the year 2020 with a life span of 2 years expectancy.

The main aim of this space mission is to study thecharacteristics of a black hole. The studying of holes is done by observing the radiation patterns of it and this is done when a star or a planet comes into contact with the black hole and as a result of it is, an enormous amount of energy and radiation being emitted. The observatory is said to be operated at the S-frequency band and Has an inclination of zero degrees. X-rays in the Range of 2-8 Kev are the focus of IXPE.

Keywords - *singularity, Imaging X-ray Polarimeter Explorer (IXPE), Gas Pixel Detector (GPD), Mirror Module Assembly (MMA), Filer Calibration Wheel (FCW), Detector Unit (DU), Detector Services Unit (DSU).*

I. INTRODUCTION

Black holes are one of the strangest objects to be present in our universe. They are formed at the end of a star's life.During a star's lifetime, nuclear fusion process takes place converting hydrogen to helium and so on. During this phase, radiation is emitted as a result of the fusion process and this radiation is balanced by the gravity of the star. At some point,iron is formed at the fusion process. Unlike otherelements, iron does not emit radiation and instead traps it. At certain point, the level of trapped radiation exceeds the level of gravity and as a result, the star implodes in a super nova explosion which results in bending of the space time and thus a black hole is born. It consists of the star's entire gravity concentrated at a smallcentral core of the black hole called the singularity.

The NASA has selected a space mission to study about the characteristics of interstellar objects such as neutron stars, black holes, quasars, pulsars and magnetars. The mission operates with the help of a spacecraft specifically designed to study such interstellar objects. It is called as the **Imaging X-ray Polarimeter Explorer (IXPE)**andis composed of three main parts namely a three-independently operating telescope system with a **Mirror Module Assembly (MMA)**, a deployable boom, and a **Gas Pixel Detector (GPD)** with a star tracker attached to its front. Objects such as black holes can heat the surrounding gases to more than a million degrees. The high energy X-ray radiation from this gas can be polarized – vibrating in a particular direction. The IXPE mission will fly three telescopes with cameras capable of measuring the polarization of these cosmic X-rays allowing scientists to answer fundamental questions about these turbulent and extreme environments where gravitational, electric and magnetic fields are at their limits.

II. IMPLEMENTATIONS

Solar Shield:Inorder to operate under the prevailing effects of the sun such as solar flares, a strong source of divergence of the solar rays is vital. This can be achieved with the help of solar shields such as optical solar reflector, ceramic cloth sunshade or a carbon foam. The telescopes also need an equal protection and hence covered with layered sunshade to keep them cool.

Rocket Propellants:Althoughchemical propellants are more popular and reliable to use, measures can be taken so as to reduce the cost and payload as well as the efficiency of the spacecraft by using ion engines which use acceleration of atoms like xenon ions through a magnetic field. It is lightweight and provides a low amount of thrust over a very long period of time hence useful for long term and deep space exploration.

But the disadvantage was that the ions corroded the walls of the space engine. But it can be rectified by diverting the magnetic field around the walls to stop ions from bombarding it. Another alternative is by using sun as a source of energy fuel such as solar sails since photons have no rest mass but have energy indicating a small amount of momentum possessed so that when they bounce off the craft's surface, they impart their momentum.

Fusion system is another alternative utilizing nuclear reactors to generate plasma that is accelerated with a magnetic field. Others use hydrogen atoms that are fused together by collapsing lithium rings around them to generate pulses of fusion.

Origami in Spacecrafts:The method of using origami in spacecrafts can help fit a lot of materials in the space craft with ease and also reduces

the load. Some examples are solar array wings using a z-folding pattern and a fan folding solar array called ultra-flex. They can also be used in starshades where extreme bright lights can be shadowed which means picturing with better clarity.

III. APPLICATIONS

With the help of the IXPE space system, we can enhance our understanding of the physical processes that produce X-rays from and near compact objects such as neutron stars and black holes.

We also get to explore the physics of the effects of gravity, energy, electric and magnetic fields at their extreme limits.

IXPE addresses key questions in High Energy Astrophysics:We get to study what the spin of a black hole is like. Not only black holes but we also get to study about the various objects of our universe such as quasars, pulsars as well as magnetars and studying their attributes such as the geometry and magnetic-field strength in magnetars.

It also answers to questions like whether our Galactic Center an Active Galactic Nucleus in the recent past and the magnetic field structure in synchrotron X-ray sources as well as the the geometries and origins of X-rays from pulsars.

Thus, the study of interstellar objects have been made easier with the help of such space programs.

Presence of blackholes, which have been a question for many years, is being confirmed.More access to the information hidden by the universe.

Detailed study on black holes and their characteristic with much longer efficiency and reliable information.

IV. SUBSYSTEM

The presence of plasma particles are found with the help of sensors located at the Detector unit.The X-rays viewed by the telescope sends information to the Detector unit which study the anisotropy of the photoelectrons by interacting them with the gaseous medium present inside it. Thus, the Detector unit is named as a Gas Pixel detector.

A **Filer Calibration Wheel** (FCW) is present at the Detector unit (DU) and it includes the polarized and non-polarized X-rays to check the calibration on orbit. A collimator sits on top of the **Detector unit** (DU) which in combination with the X-ray shield along the Mirror Module Assemblyblocks Off-Radiations from entering the detectors.

The **Detector Services Unit (DSU)** provides the needed secondary power lines to the DU, controls each DU, manages their FCW and high voltage operations, provides thermal control of GPD, processes and formats scientific data and interfaces to the spacecraft avionics.

During normal mission operations, the spacecraft generates 300 W orbit average power (OAP); the payload uses ~100 W between the different payload elements including thermal control. The payload is provided with switched power feeds. Each power feed provides unregulated 28 ±6 VDC from the spacecraft.

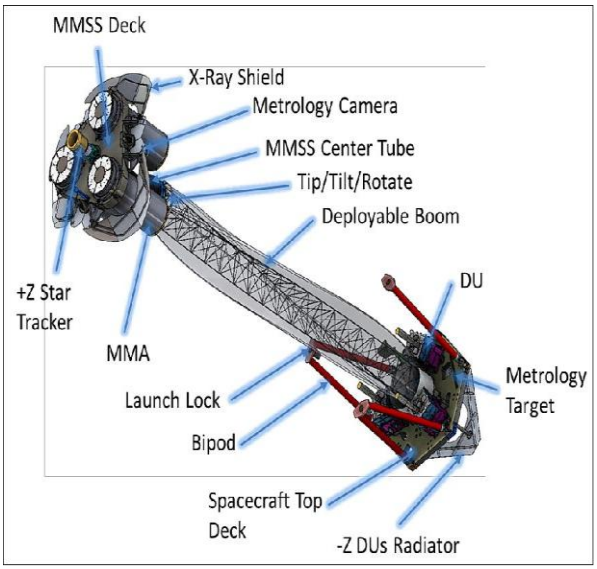

Fig 1. IXPE payload views showing key elements

V. CONCLUSION

Thus, the IXPE space mission proves to be a very efficient scientific mission which can provide answers to the many hidden secrets of our universe. Also, a more advanced version of the scientific discoveries will be obtained with the help of this mission.

ACKNOWLEDGEMENT

The major contributor of this mission is the NASA which is currently undertaking the construction of this spacecraft which is expected to launch by 2020. Their contributions towards the space research have been marvellous and are seen to be exceeding in their work day by day. This idea was however proposed under the major influence of the Einstein's theory where he proved the existance of black holes. It is also derived from various other equations including the Schwarzchild radius and Newton's law of gravity.

REFERENCES

[1] NASA Selects Mission to Study Black Holes, Cosmic X-ray Mysteries ," NASA Release 17-002, January 3, 2017, URL https://www.nasa.gov/press-release/nasa-selects-mission-to-study-black-holes-cosmic-x-ray-mysteries

[2] NASA to Peer Through a New Window at Black Holes and Exotic Astronomical Objects," Satnews Daily, Jan. 8, 2017, URL: http://www.satnews.com/story.php?number=1942514205

[3] William Deininger, "IXPE: Imaging X-Ray Polarimetry Explorer Mission," 2017 IEEE Aerospace Conference, Yellowstone Conference Center, Big Sky, MT,USA,March4/11/2017,URL:https://wwwastro.msfc.nasa.gov/ixpe/for_scientists/presentations/20170304_deininger.pdf

[4] IXPE mission: Italy and NASA for new X-ray astronomy," INFN, INAF, January 16, 2017, URL:https://www.researchitaly.it/en/projects/ixpe-mission-italy-and-nasa-for-new-x-ray-astronomy/

[5] W.D.Deininger, R. Dissly, J. Domber, J. Bladt, J. Jonaitis, A. Kelley, R Baggett, B. D. Ramsey, S. L. O'Dell, M. C. Weisskopf, P. Soffitta, "Small Satellite Platform Imaging X-Ray Polarimetry Explorer (IXPE) Mission Concept and Implementation," Proceedings of the 31st Annual AIAA/USU Conference on Small Satellites, Logan UT, USA, Aug. 5-10, 2017, paper: SSC17-III-08, URL: http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=3616&context=smallsat

[6] William D. Deininger, William Kalinowski, H. Kyle Bygott, Brian Smith, Colin Peterson, Spencer Antoniak, Jennifer Erickson, Sandra Johnson, James Masciarelli, Jeff Bladt, D. Zach Allen, Jeff Wedmore, Tim Read, Janice Houston, Brian D. Ramsey, Steve L. O'Dell, Michele Foster, Ettore Del Monte, Francesco Santoli, Alessio Trois, Michele Pinchera, Massimo Minuti, Darren Osborne, Mike McEachen, "Small Satellite Platform Imaging X-Ray Polarimetry Explorer (IXPE) Mission Concept and Implementation," Proceedings of the 32nd Annual AIAA/USU Conference on Small Satellites, Logan UT, USA, Aug. 4-9, 2018, paper:SSC18V08,URL: https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=4093&context=smallsat

[7] IXPE Imaging X-Ray Polarimeter Explorer," NASA, URL:https://wwwastro.msfc.nasa.gov/ixpe/about/index.html