# Asteroid Mining and Spectroscopy

Aric Apoorv Tirkey

This report covers the topics like Asteroid Mining , Spectroscopy and its types and Optical Spectrometer. This report is based on online articles from prominent sources.

## 1 Contents

- Asteroid Mining
- Spectroscopy
- Optical Spectrometer

## 2 Asteroid Mining

Asteroid mining is as an innovative method to obtain resources from asteroids which contain a lot more resources that Earth does. Companies like Planetary Resources and Deep Space Industries initiated efforts in 2012 to explore this field, identifying approximately 15,000 asteroids with significant mining potential.While specific estimates of the cost of commercial mining remain unclear, similarities can be drawn between such programs and NASA's OSIRIS-REx mission, which seeks to obtain samples from a near-earth asteroid named Bennu. Despite only being projected to return between 400 grams and 1 kilogram of material, the mission is projected to take 7 years and cost over USD 1 billion.Despite the high price, the development of asteroid mining technology may be a great endeavor because of the valuable resources these asteroids offer.

Asteroid mining could eliminate the environmental damage caused by terrestrial mining, such as water pollution and habitat destruction. It also offers a means to address ethical concerns, in regions like the Democratic Republic of the Congo, where cobalt mining has been linked to child labor and hazardous conditions.

However if made possible it would very badly impact Earth's mining industry leaving several people jobless. Many countries depend on resource exports and they'll face bad consequences. Poor countries who can't develop this technology will suffer.

The development of asteroid mining technology faces significant challenges, like the need for advanced robotics, reliable propulsion systems, and sustainable life support for extended missions. Moreover there are no laws to govern Asteroid mining and may lead to over exploitation.

# 3 Spectroscopy

Spectroscopy is a technique used to analyze the interaction between electromagnetic radiation and matter. It involves measuring how different substances absorb, emit, or scatter radiation of different wavelengths which reveals information about the structure, composition, and physical properties of the substance. Spectroscopy is done through Spectrometers that consist of a Source, Grating and a Detector.

Bascially there are two types of spectroscopy. Absorption which makes light move through gaseous particles that absorb some wavelengths to excite the molecules and then we analyse the transmitted rays. Emission in which light already excites the material then when it dexcites it releases particular wavelengths which we observe.

Spectroscopy helps us learn about the structures of atoms and molecules based on which wavelengths of radiation they absorb and emit. In Astronomy spectroscopy is largly used to analyse the composition of celestial objects based on the light that comes from them. It is also used in many other fields like Forensics, Medicine, Gemology and Environmental Monitoring.

## 3.1 Spectrum

Spectrum is basically a band of wavelengths we obtain by breaking the light coming from a source into its constituent wavelengths. Absorption Spectrum is a continuous band of colours which few black lines indicating the wavelengths that get absorbed. Emission spectrum is mostly a black band with discrete lines that are the wavelengths that are emitted by the substance.

## 3.2 Methods for dispersing light

This is basically the work of a grating.

- Refraction: It uses glass prisms which disperses light into its constituent wavelengths when light passes through it. It occurs because of the difference in speeds of different wavelengths in a medium.

- Diffraction: Diffraction gratings are used for this.A diffraction grating consists of many closely spaced slits or grooves, typically hundreds to thousands per millimeter.When light hits the grating, each slit acts like a secondary source of wavelets (based on Huygens' principle).If light having several constituent wavelengths falls upon a grating at a fixed angle i, different wavelengths are diffracted in slightly different directions and can be observed and recorded separately. Each wavelength is also diffracted into several orders (or groupings); gratings are usually blazed (engraved) so that a particular order will be the most intense. As a result Light of different wavelengths is spread out at different angles, forming a spectrum.

- Interference: An Interferometer is used for this.A beam of light (usually from a laser) is split into two paths by a beam splitter. Each light beam travels a different path and then recombines.When the two beams meet again, they interfere are form a spectrum.

# 4 Molecular Spectroscopy

Molecular spectroscopy is the study of how molecules interact with electromagnetic radiation. It provides information a molecule's structure, bonding, energy levels, and how it absorbs, emits, or scatters light.

## 4.1 Energy states of a molecule

- Electronic States:It refers to the energy of electrons in molecular orbitals. Transitions occur in UV–Visible regin of the spectrum.
- Rotational States:It refers to rotation of the molecule as a whole. It occurs in Microwave region.
- Vibrational States:It is the vibration of atoms within the molecule. It occurs in Infrared region.

Each energy state transition corresponds to absorption or emission of light at a specific wavelength. This is the basis of molecular spectroscopy.

## 4.2 Fields of Molecular Spectroscopy

- Microwave Spectroscopy
- Vibrational Spectroscopy
- Raman Spectroscopy
- UV-Vis Spectroscopy
- Photoelectron Spectroscopy
- X-Ray Spectroscopy
- Radio-frequency Spectroscopy
- Resonance-ionization Spectroscopy

# 5 Optical Spectrometer

A Spectrometer is a device used to break light into its constituent wavelengths and detect the formed spectrum. It is used in Spectroscopy techniques. Spectrometers operate over a wide range of non-optical wavelengths, from gamma rays and X-rays into the far infrared.

Spectrometers are used in many fields. For example, they are used in astronomy to analyze the radiation from objects and deduce their chemical composition. Here they usually form Emission Spectra.

Early spectroscopes were simply prisms with graduations marking wavelengths of light. Modern spectroscopes generally use a diffraction grating, a movable slit, and some kind of photodetector, all automated and controlled by a computer. Joseph von Fraunhofer developed the first modern spectroscope by combining a prism, diffraction slit and telescope in a manner that increased the spectral resolution.

In the original spectroscope design in the early 19th century, light entered a slit and a collimating lens transformed the light into a thin beam of parallel rays. The light then passed through a prism that refracted the beam into a spectrum. This image was then viewed through a tube. With the development of photographic film, more accurate specta was created. It was based on the same principle as the spectroscope, but it had a camera in place of the viewing tube. In recent years, the electronic circuits built around the photomultiplier tube have replaced the camera. Arrays of photosensors are also used in place of film in spectrographic systems.

## 5.1 Spectrograph

A spectrograph is an instrument that separates light into its wavelengths and records the data. A spectrograph typically has a multi-channel detector system or camera that detects and records the spectrum of light. The first spectrographs used photographic paper as the detector while recent ones use electronic detectors such as CCDs which can be used for both visible and UV light.