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Hydrogen Probe

KEYWORDS

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ABSTRACT *The Universe is infinite as every day a new universe is created. Different types of celestial bodies such as asteroids planets comets etc. come near to our home planet earth for some interval of time. To study the characteristics of such celestial bodies, we came up with an the idea of Hydrogen probe*

A hydrogen filled weather balloon made up of rubber (envelope or latex) could be used for getting the experimental data of the celestial bodies without going into space and spending large sum of money. The probe will consist of a payload that will be having the high definition camera attached to the telescope and the whole setup attached to a programmed camera gimbal to click the pictures of comets, asteroids and planets that come near earth and it also will have spectrograph and chronograph to study the characteristics such as velocity, volume, weight, materials, diameter and radiation. The reason to use this setup so that we can get to know about the characteristics of a celestial body such as asteroid or comet as it may get destroyed by entering our atmosphere or by the sun. Even students can perform this experiment and learn and explore new things about space dynamics and astronomy at economical cost. Recently we conducted the experiment to click the pictures of ISON comet that passed through earth on 27th November 2013 by sending our payload to an altitude of 18,000 meters. The Hydrogen probes can go up even to an altitude of 50,000 meters. We can get on board data from the payload by setting up a ground station and using global positioning system like Ublox Lea-5h of frequencies 400-406 MHz's.

Chronograph can be attached in front telescope with RGB (Red-Green-Blue) filters to capture the corona of the comet or asteroid that is travelling at an extremely high velocity and it also gives a two-dimensional analysis of coronal discharge of atoms. They are travelling at very high velocity due to the gravitation pull of the Sun and kinetic energy with respect to their mass according to newton's law of gravitation. Spectrometer can be used to analyse and measure properties of light over a specific portion of Electromagnetic spectrum and through this we can identify materials of the celestial body along with the spectrum of the body and the frequencies of light it emit. Using this data we can process its values in analysis software's such as SEQUES, Mascot and can get to analyse its structure. The weather balloon will burst after a particular altitude due to decrease in the pressure of surrounding and can safely brought to ground using parachutes or gliding surfaces. The Gimbal is used to counter the rotation of payload with respect to celestial body.

INTRODUCTION: - the Hydrogen probe is basically an experiment and an analysis that could be done in order to fetch the meteorological data at a certain altitude. In this experiment a balloon was sent up to a certain altitude in the upper atmosphere. The balloon maybe of any material such as latex or any other suitable material which could sustain at that particular height. The weather balloons are easily available in the markets so it is very easy to perform such an experiment. The basic aim behind this experiment is to obtain the photographs of celestial bodies such as comets etc., which will pass by the earth at different times during the year. The probe would also provide data about the following parameters such as temperature, humidity, wind velocity, pressure density etc. The probe is cost effective as far the materials and other electronic instruments are concerned, with the help of this experiment any small organisations or students can gain knowledge about the atmosphere and its various layers as well as explore the possibilities of space. The hydrogen probe would be able to attain a very high altitude. The data that we would be getting from the payload would be received by the ground station from where we could retrieve this information.

WORKING: - A reusable hydrogen probe can be constructed in a form a payload that will consist of electronic equipment's for performing scientific experiments. The probe will be tethered with a weather balloon which can be filled with hydrogen or helium gas. The probe will be constructed using Styrofoam and acrylic sheets to provide insulation from high temperatures in its surrounding atmosphere. The apparatus was constructed in our college as a student science project for attempting to click the picture of the ISON comet on 28th November 2013 by attaching a camera to the telescope, but this comet later evaporated and thus the picture could not be taken. The payload was lifted with an ascent speed of 5-7m/s to an altitude of 18000m after taking the permission from air traffic control. We can construct the same payload using apparatus like spectrometer and chronograph for acquiring data regarding any asteroid, comet or celestial body and further analysis can be done to obtain results. Spectrometer can be used to analyse properties of light over a specific por-

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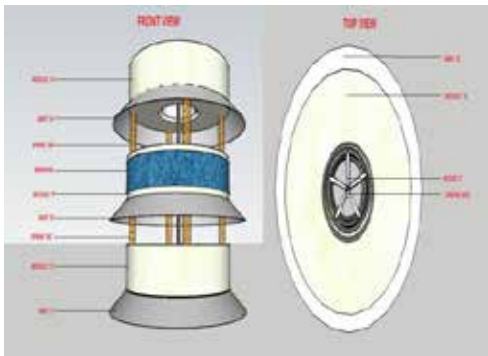
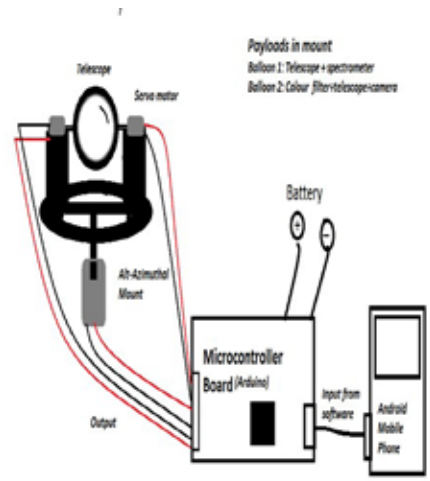
tion of Electro Magnetic spectrum and through this we can identify materials of the celestial body.



Diagrammatic representation of payload.



Working diagram for setup.

We can acquire data regarding the spectrum of the body and the frequencies of light it emit. Using this data we can process its values in the analysis software's such as SEQUES where we get to analyse its structure. To click the picture of the celestial body we can use Red Green Blue filters. Chronograph can be attached in front telescope to capture the corona of the comet or asteroid that is travelling at an extremely high velocity and it also gives a two-dimensional analysis of coronal discharge of atoms. We can get on board data from payload by setting up a ground station and using global positioning system like Ublox Lea-5h of frequencies 400-406 MHz's. While conducting the experiment we were able to get the data of change in pressure, temperature and wind velocity as per increase in altitude and the graphs were plotted. Before conducting the experiment launch site was finalised with its GPS coordinates depending upon weather conditions during November. An average of last ten years data of wind speed components with respect to altitude was plotted on graph using Mat lab software. The graphs were plotted to predict the trajectory of the payload after it falls due to bursting of balloon. Due to decrease in the pressure in the surrounding, gas inside balloon will tend to expand ultimately bursting the balloon. Another problem was the surrounding temperature at high altitude in stratosphere, temperature drops to negative temperature example: at 30000m temperature is -60 degree Celsius. So the payload was constructed with Styrofoam while the equipment batteries were insulated with thermo Cole and hand warmers (used during rescue missions in hilly areas to raise temperature by 30 degree Celsius). Hand warmers were used because temperature outside decreased rapidly and it would drain the battery quickly. Solar panels can be used as an alternative for power generation. Now the problem came in clicking the picture of comet as payload was rotating due to earth's magnetic flux to counter that we brought in an idea of solar tracker. To counter such problems we can use various alternatives such as:

A gimbal which will be pre-programmed with coordinates of the comet can be used and camera can be mounted on it, so it will counter the rotation.

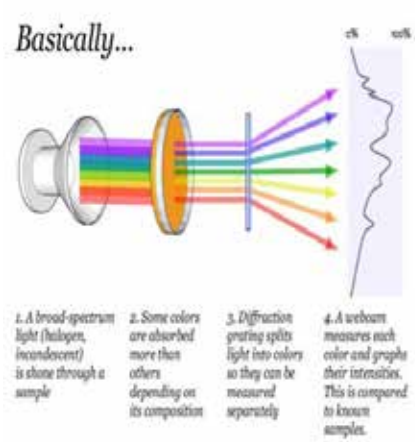
A base using servos can be constructed that can take input from sensors such as LDR or Infrared sensors and can rotate in opposite direction of payload to counter the motion and produce 0 relative angular displacement with respect to the payload.

If we are sending the payload to low altitudes, we can use propeller motors to produce counter rotation torque and its rpm can vary depending upon the rotation of the payload to nullify the angular displacement.

Gyroscope sensors can be used in the constructed base to counter the rotation.

We can use android phone and connect with microcontrollers. Phones can be used for giving input to microcontroller which will further process the data and give output to the servo motors of the counter rotation mount. Servo motors of metal shafts can be used instead of plastic, as due to low temperature the plastic may become brittle and break due to high torque.

The weather balloons are available in the markets that are made of latex or envelope (rubber). The weight of our payload was 2900 grams. In case of carrying large amount of weight two balloons can be used and tethered together along with the payload. When the balloon burst after successful experiment parachutes must be deployed to decrease the terminal velocity of the payload and get it down safely so that its equipment does not affect the people while it is falling with high kinetic energy. We can also construct the payload in such a way that its surface produces huge drag and it can safely glide and come to the ground. The best thing about this whole experiment is that not only big organisations but the same thing can be done at student level. We can also study the Doppler's Effect in the atmosphere using the same payload.



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III. CALCULATIONS:-

Lift = V * (P/2.87) * ((1/T1)-(1/T2))

Where

Lift = Balloon lift (kg)

V = envelope volume (m^3)

P = pressure at the operating altitude (hpa)

T1 = Ambient temperature (kelvin)

T2 = Envelope temperature (kelvin)

Drag Force on parachute

( ) = 0.5 ^{2}

Where, ρ = Density of air

v = velocity of Descent

A = Surface area of parachute

C_d= Co-efficient of Drag

At equilibrium, drag force = weight of the payload

Velocity of descent,

$$v = \sqrt{\left\{2 * \frac{W}{\rho * S * Cd}\right\}}$$

Where,

S= Reference Area

W= Weight of the Payload

Diameter of parachute,

$$\varphi = \sqrt{\frac{8WL}{\Pi\ \rho\ v^2\ Cd}}$$

Where, ϕ=Diameter of the Parachute

Hydrogen Requirements

Lift power of hydroden - 1.2kg per litre
1kg - 833.333 lit
2.5kg - 2083.325 lit
3 kg - 2499.99 lit

- 1 balloon - 2.5 kg 2083.325 lit
- 5 balloons - 10416.67 lit
- **2 hydrogen cylinders - 14000 lit**

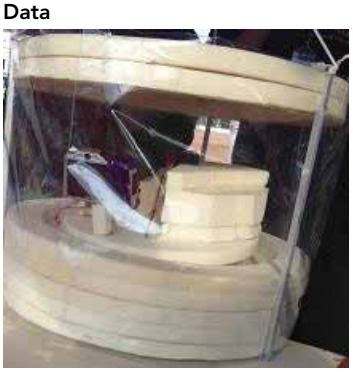
Latex balloon

IV. EXPERIMENTAL SETUP:-

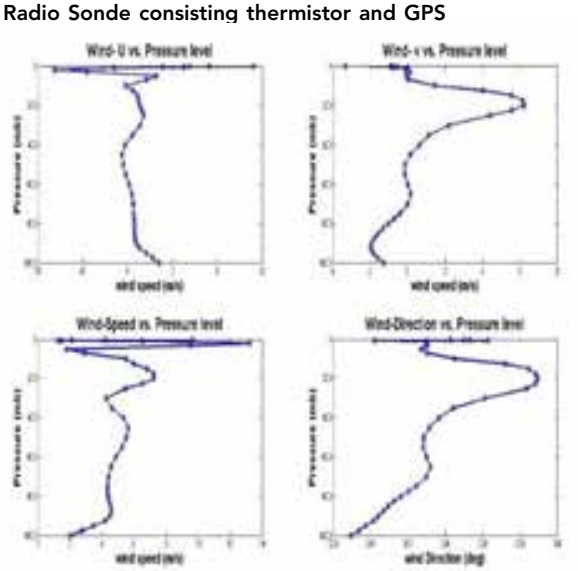
V. RESULTS:-

Data

GPS



Radio Sonde consisting thermistor and GPS



Experimental Graph

Payload made up of Styrofoam

REFERENCE [1] NARL- National atmospheric research laboratory. | [2] IMD- Indian Meteorological Department | Chennai | [3] www.ecmwf.int/en/research/climatereanalysis/era-interim [4] predict.habhub.org/ |