

B.A. PART - 1 (PHYSICAL GEOGRAPHY : PAPER - 1)

TOPIC : TIDAL HYPOTHESIS OF ORIGIN OF SOLAR SYSTEM

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TIDAL HYPOTHESIS OF JAMES JEANS

Sir James Jeans, a British scientist, propounded his 'tidal hypothesis' to explain the origin of the earth in the year 1919 while another British scientist, Harold Jeffreys, suggested modifications in the 'tidal hypothesis' in 1929 and thus made it more relevant and significant in the context of increasing knowledge of the cosmogonic ideas of the 1st quarter of the 20th century. Tidal hypothesis is one of the modern hypotheses of the origin of the earth and the solar system.

Jeans postulated his hypothesis on the basis of certain axioms (self-proved facts) as given below:

- (1) The solar system was formed from the sun and another intruding star.
- (2) In the beginning the sun was a big incandescent gaseous mass of matter.
- (3) Besides the sun, there was another star termed as 'intruding star' in the universe. This intruding star was much bigger in size than the primitive sun.
- (4) The primitive sun was stationary and was rotating on its axis.

(5) The 'intruding star' was moving along such a path in such a way that it was destined to come nearer to the primitive sun.

(6) There was a great impact of the tidal force of the intruding star on the surface of the primitive sun.

James Jeans postulated that due to massive gravitational force of the 'intruding star', huge amount of matter was ejected from the primitive sun, which later on became the building material of future planets. According to the Newton's law of universal gravitation (1687) everybody in the universe attracts every other body with a force which is directly proportional to the product of the masses of the two bodies and inversely proportional to the square of the distance between them.

Evolution of filament:

According to James Jeans the 'intruding star' was continuously moving along such a path that it was coming nearer to the primitive sun and thus exerted gaseous tidal force (gravitational pull) on the surface of the 'primitive sun'. As the 'intruding star' came nearer and nearer to the 'primitive sun', its gravitational force went on increasing with the result tidal force also increased.

When the 'intruding star' came nearest to the 'primitive sun' its gravitational force became maximum, with the result a giant cigar-shaped tide, thousands of kilometres in length, was created on the outer surface of the 'primitive sun' and ultimately huge mass of matter, in the shape of a cigar, was ejected from the 'primitive sun'. James Jeans called this cigar-shaped matter as filament which was much thicker in the centre and thinner and sharper at the ends (tapering ends).

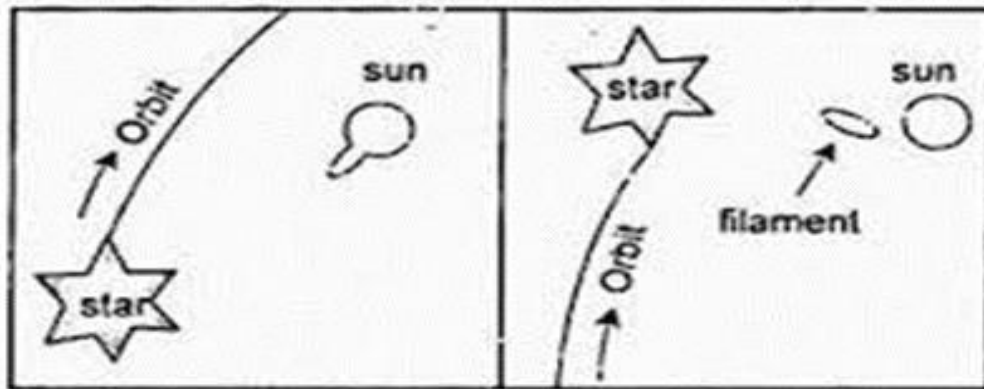


Fig. 2.1 : Formation of planets according to tidal hypothesis.

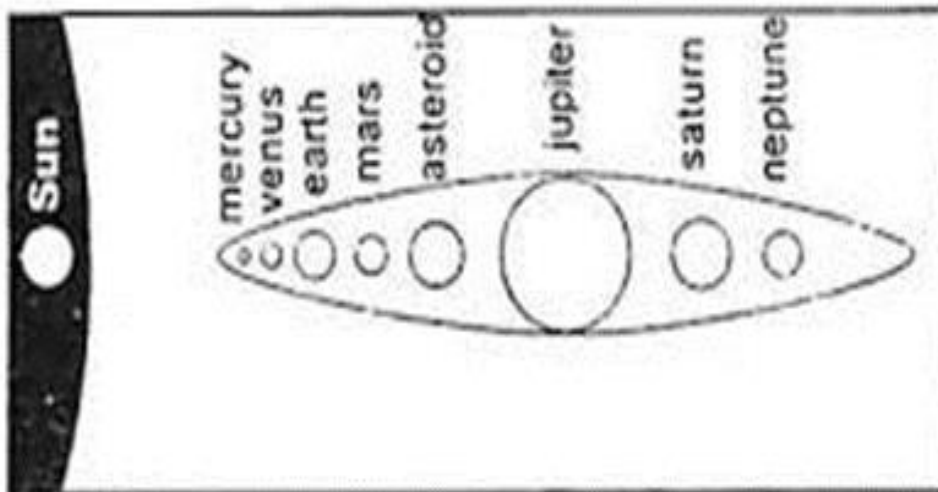


Fig. 2.2 : Cigar-shaped arrangement of the planets of our solar system. Pluto is no longer a planet but is designated as a 'dwarf planet'.

Formation of planets from the filament:

According to James Jeans nine planets of our solar system were formed due to cooling and condensation of the incandescent mass of gaseous matter of the filament. The filament, after being detached from the sun, began to cool down. Thus, the filament started contracting in size on cooling. The contraction of the filament led to its breaking in several pieces and each piece was condensed to form one separate planet. This process led to the formation of nine planets.

The filament of incandescent gaseous matter allowed bigger planets to form in its middle portion (like Jupiter and Saturn) and smaller ones towards its tapering ends. The remaining part of the primitive sun became our sun. The satellites of the planets were formed due to gravitational pull and tidal effect exerted by the sun on the outer surfaces of the newly formed planets.

The processes of the formation of satellites ceased when the amount of matter ejected from the planets for the formation of new satellites became so low that it was not able to hold together its matter by its central gravitational force/attraction.

The rate of cooling of the primitive incandescent gaseous planets was dependent upon the size of the planet. The planets of greater mass cooled very slowly while the smaller planets and satellites condensed to liquid and then to solid forms within very short period. This may be the possible reason for larger number of satellites of bigger planets and fewer number of satellites of smaller planets.

Very small planets were cooled and condensed soon, so no matter could be ejected from their surface due to tidal effect and thus no satellite could be formed. This is why Mercury, Venus and Pluto do not have any satellite.

Modification by Jeffreys:

Harold Jeffreys, a British scientist, modified the original tidal hypothesis of James Jeans in 1929 and presented his concept as 'collision hypothesis'. According to Jeffreys there were three stars in the universe before the origin of our solar system. One was our primitive sun, the second one was its 'companion star' and the third one was 'intruding star' which was moving towards 'companion star'.

Thus, the intruding star collided against the 'companion star'. Due to head-on collision the companion star was completely smashed and shattered, some shattered portions were scattered in the sky while remaining debris started revolving around the primitive sun. However, the impact of collision and explosion enabled the intruding star to clear itself off from the gravitational attraction of the primitive sun and gradually vanished in the universe.

The planets of our solar system were formed from the remaining debris of the companion star. It may be pointed out that Jeffreys suggested modifications in the tidal hypothesis of James Jeans with the intention to remove major inherent weak points of the tidal hypothesis so that it can withstand the criticisms of the modern scientific world.

Evaluation:

The tidal hypothesis as propounded by James Jeans and modified by Harold Jeffreys enjoyed a long lease of popularity and wide appreciation till the end of the 1st half of the 20th century because of its simplicity, inherent logic and scientific appeal but the hypothesis was severely criticised on various grounds. Even Jeffreys accepted in Guttenberg (1951) that his modified version of tidal hypothesis needed substantial modifications and in some places was completely wrong.

The following criticisms have been labelled against this hypothesis:

- (1) According to B. Levin the universe is infinite in space and time and the stars are so distant from each other that such a close encounter between them is a remote possibility.
- (2) James Jeans did not explain the where about and destiny of the intruding star/which caused tidal, eruption on the surface of the primitive sun in the form of filament.
- (3) N.N. Parisky has proved on the basis of mathematical calculation that tidal hypothesis fails to explain the real distances between the sun and the planets in our present solar system.
- (4) The planets of our solar system are largely formed of the elements having high atomic weight but the constituent elements of the sun (from which the planets are supposed to have been formed) are of lighter atomic weight e.g. hydrogen and helium. The tidal hypothesis fails to offer convincing explanation for such anomalous situation,
- (5) James Jeans could not elaborate the process and mechanism of the condensation of matter ejected from the primitive sun.

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