TIDES – TYPES AND FORMATION

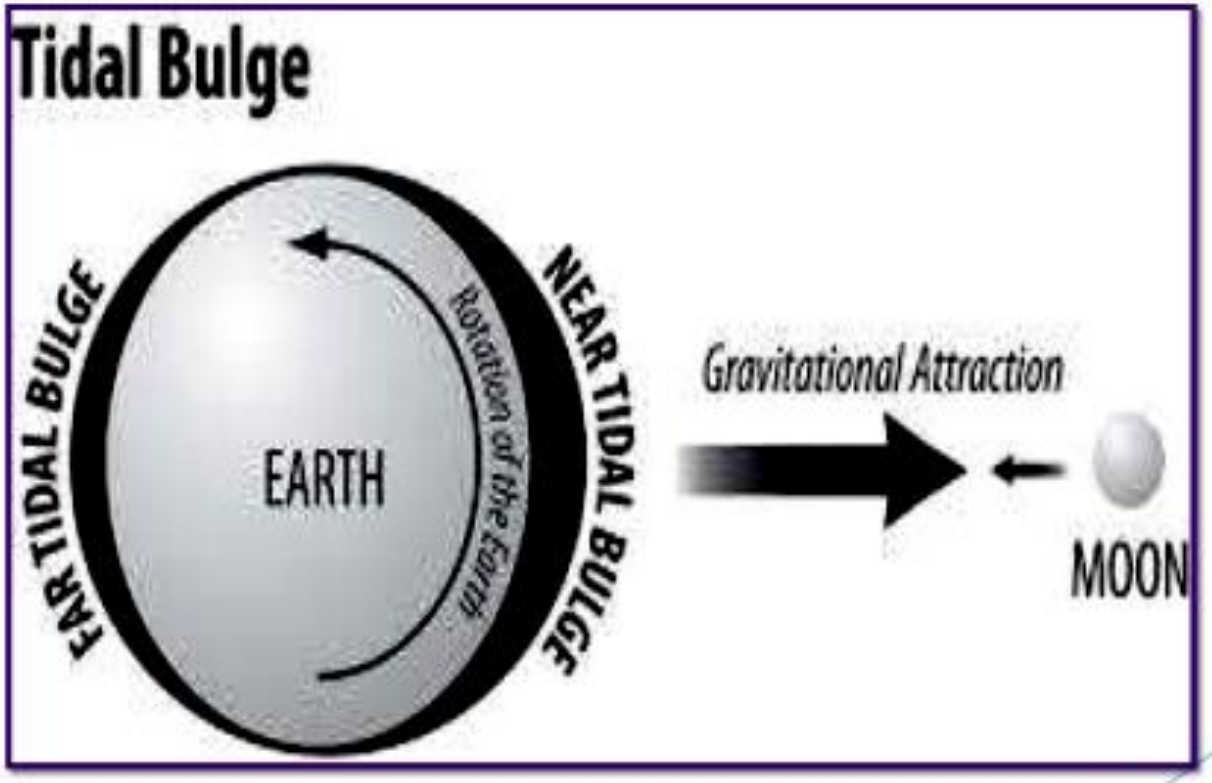
DIPANKAR CHAKRABORTY
COLLEGE TEACHER
RANIGANJ GIRLS' COLLEGE

INTRODUCTION

- An ocean tide refers to the cyclic rise and fall of seawater.
- Tides are caused by slight variations in gravitational attraction between the ***Earth*** and the ***moon*** and the Sun in geometric relationship with locations on the Earth's surface.
- Tides are periodic primarily because of the cyclical influence of the Earth's rotation.

TIDAL BULGE

- The moon is the primary factor controlling the temporal rhythm and height of tides .
- The moon produces two tidal bulges somewhere on the Earth through the effects of gravitational attraction.
- The height of these tidal bulges is controlled by the moon's gravitational force and the Earth's gravity pulling the water back toward the Earth.
- At the location on the Earth closest to the moon, seawater is drawn toward the moon because of the greater strength of gravitational attraction.
- On the opposite side of the Earth, another tidal bulge is produced away from the moon.
- However, this bulge is due to the fact that at this point on the Earth the force of the moon's gravity is at its weakest.
- Considering this information, any given point on the Earth's surface should experience two tidal crests and two tidal troughs during each tidal period.


Tidal Bulge
FAR TIDAL BULGE
NEAR TIDAL BULGE
EARTH
Rotation of the Earth
Gravitational Attraction
MOON

TIDAL PERIOD

- The timing of tidal events is related to the Earth's rotation and the revolution of the moon around the Earth.
- If the moon was stationary in space, the tidal cycle would be 24 hours long. However, the moon is in motion revolving around the Earth.
- One revolution takes about 27 days and adds about 50 minutes to the tidal cycle. As a result, the tidal period is 24 hours and 50 minutes in length.
- The second factor controlling tides on the Earth's surface is the Sun's gravity. The height of the average solar tide is about 50% the average lunar tide.
- At certain times during the moon's revolution around the Earth, the direction of its gravitational attraction is aligned with the Sun's .
- During these times the two tide producing bodies act together to create the highest and lowest tides of the year. These springtides occur every 14-15 days during full and new moons.
- When the gravitational pull of the moon and Sun are at right angles to each other, the daily tidal variations on the Earth are at their least.
- These events are called neap tides and they occur during the first and last quarter of the moon.

HIGH TIDE AND LOW TIDE

- When the gravitational pull is at its highest point, the result is **high tide**, which is the highest level of the tide. When the pull is at its lowest point, we see **low tide**, or the lowest level of the tide.
- The earth itself is also pulled toward the moon but with less strength. This pulls the earth away from the water on the opposite side of the earth, making the water on that side bulge as well.
- Therefore, high tide occurs on both sides of the planet at the same time. Meanwhile the earth is rotating. So, we experience tides throughout the day.

LOW TIDE

HIGH TIDE

TYPES OF TIDES

Based on the number of high and low tides and their relative heights each tidal day, tides are described as semi-diurnal, mixed, or diurnal.

SEMIDIURNAL AND DIURNAL TIDES

- Now, if the earth were perfectly round with no big land masses, all bodies of water in the world would experience two nearly equal high tides and two low tides each day.
- This tidal pattern is known as **semidiurnal tides**.
- However, the continents of earth disrupt water bodies, and so this can produce different tidal patterns. For example, some bodies of water, such as the Gulf of Mexico, have **diurnal tides**, which means only one high tide and one low tide each day.

Mixed tides

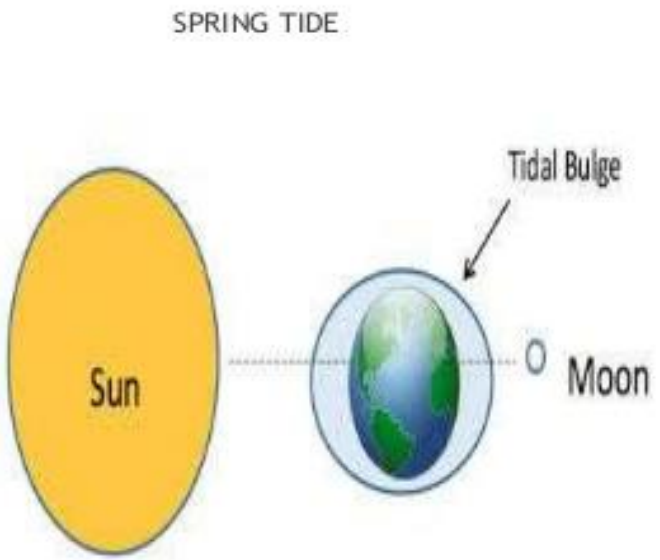
- Many parts of the world experience mixed tides where successive high-water and low-water stands differ appreciably In these tides, we have a higher high water and lower high water as well as higher low water and lower low water

SPRING TIDES AND NEAP TIDES

- The earth and moon are constantly in motion around the sun, and all have their own gravitational pull.
- So, when the alignment between the three bodies changes, it changes the strength of the overall gravitational pull and therefore the size of the tides.

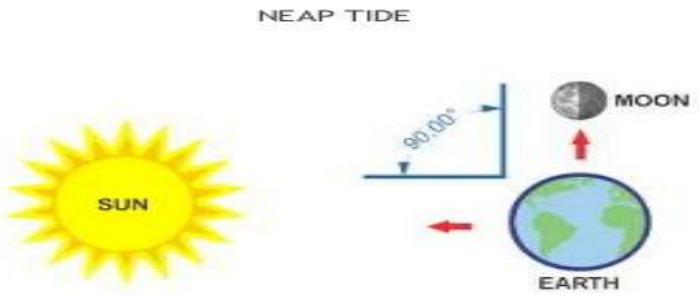
SPRING TIDES

- **Spring Tides** are tides that occur when the earth, moon and sun are aligned, and the tidal range between high and low tide is at its maximum.
- This happens basically twice a month, during the full and new moon phases.
- At these times, the three bodies are in line and their gravitational pulls reinforce each other. When the spring tide is happening, we see higher than average high tides and lower than average low tides.


SPRING TIDE
Tidal Bulge
Sun
Moon

NEAP TIDES

- A few weeks after the spring tides, we see the **neap tides**.
- These are tides that occur when the moon and sun are at right angles to the earth's orbit, and the tidal range between high and low tide is at its minimum.
- The neap tides occur when the moon is in its first and last quarter phase.
- Because of the position of the moon and sun, their gravitational pulls on the waters of earth partially cancel each other out, resulting in smaller differences between the high and low tides.



TIDAL BORE

- In shallow steep funnel shapes rivers the tides enhances as a single wall of water.
- This is called tidal bore.
- These tides move with a speed of 25km.
- They move up to height of 8 m.
- These tidal bores are commonly seen in Quintang river, Amazon, Bay of Fundy and many English and French rivers.

The Tide-Generating Forces

- As the earth revolves around the gravitational centre of the sun/earth system, the orientation of the earth´s axis in space remains the same. This is called revolution without rotation .
- The tide generating force is the sum of gravitational and centrifugal forces. In revolution without rotation the centrifugal force is the same for every point on the earth´s surface, but the gravitational force varies .
- It follows that the tide generating force varies in intensity and direction over the earth's surface. Its vertical component is negligibly small against gravity; its effect on the ocean can be disregarded. Its horizontal component produces the tidal currents, which result in sea level variations.
- The gravitational force exerted by a celestial body (moon, sun or star) is proportional to its mass but inversely proportional to the square of the distance.
- The Sun's mass is equivalent to some 332,000 Earth masses, while the mass of the Moon corresponds to only 1.2 percent of the mass of the Earth.

- The mean distance Sun -Earth is 149.5 million km, the mean distance Earth - Moon only 384,000 km. If the gravitational force of the Sun and Moon are compared, it is found that the Sun's enormous mass easily makes up for its larger distance to Earth, to the extent that the gravitational force of the Sun felt on Earth is about 178 times that of the Moon.
- As a result the Earth's orbit around the Sun is not seriously distorted by the Moon's movement around the Earth.
- However, as is evident, tides are not produced by the absolute pull of gravity exerted by the Sun and the Moon but by the differences in the gravitional fields produced by the two bodies across the Earth's surface.
- Because the Moon is so much closer to the Earth than the Sun, its gravitational force field varies much more strongly over the surface of the Earth than the gravitational force field of the Sun.
- Quantitative analysis shows that the *differences* of the gravitational forces across the Earth's surface are proportional to the *cube* of the distances Sun - Earth and Earth - Moon.
- As a result the Sun's tide-generating force is only about 46% of that from the Moon. Other celestial bodies do not exert a significant tidal force.

Tides and Marine Organisms

- Tides have a profound affect on coastal marine life.
- Coastal life is sorted into zones and subzones, depending on the amount of emergence and submergence the organisms can tolerate.

Power from Tides

- Electricity can be generated from tidal currents if the tidal range is greater than 5 m in a large bay connected to the ocean by a narrow opening.
- A dam is constructed across the opening and water is allowed to flow into and out of the bay when sufficient hydraulic head exist to drive turbines and generate power.
- The first major tidal power station, in France, is capable of generating 544 million kilowatt hours of electricity annually.