International Folkdance & Eclipse Info events

Use the **Breakout Rooms** button to join these events. You may have to click a three-dots icon (...) to see the button. In the Breakout Rooms window, click the word "join" or the number on the far right of the line to go to a room.

To get back to Israeli, use the "Leave Room" button.

If you can't find the **Breakout Room** you may need to update to the lates Chat with Phil Colin or Stuart to lea

Eclipse 101: The Basics

Coming soon to this breakout room!

Larry Denenberg Hora Eclipse 1.5V December 14, 2020



Eclipse 101: The Basics

(Put questions in the chat, or just speak up!)

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What is an Eclipse?

- An eclipse happens when sun, moon, and earth line up (called syzygy, awesome Hangman word).
- Lunar eclipse: Earth casts a shadow on the moon
- Solar eclipse: Moon casts a shadow on the earth



What is an Eclipse?

- When the moon gets between the sun and the earth, it casts a shadow, just like anything else. Anyone inside that shadow sees a solar eclipse.
- If the moon *completely* blocks the sun, it's a total eclipse.
 If the moon blocks *part* of the sun, it's a **partial** eclipse.
- The apparent size of the moon is almost exactly the same as that of the Sun. Hence total eclipses are rare.
- The eclipse is visible along a west-to-east path as the moon travels in its orbit.



Types of solar eclipse

- **Partial**: The moon partially but never fully covers the sun.
- Total: The moon entirely covers the sun. People near but outside the narrow path of totality see only a partial eclipse. Most solar eclipses are partial only, with no path of totality.
- Annular: The moon is too far away to cover the sun; the sun shows all around it in a "ring of fire". There was such an eclipse June 21 this year, visible in Africa, India, and China.
- Annular-total (or hybrid; rare): An annular eclipse that becomes total as it progresses; the curvature of the earth's surface reduces the distance to the moon.



Eclipse facts

- Each spot on earth sees a total solar eclipse about once every 375 years. Lunar eclipses are visible everywhere.
- Longest possible total solar eclipse: about 7.5 minutes.
- The moon is receding at 1.5 inches/year: The last-ever total solar eclipse will occur in about 600,000,000 years.
- The shortest day of the year is the winter solstice, usually 12/21. But the earliest sunset occurs a couple weeks earlier; the latest sunrise a couple weeks later. This has nothing to do with eclipses.



Progress of an eclipse, 1

- **First contact** (C1): The disc of the moon touches the sun. Boring for awhile.
- Baily's beads: Points of light caused by the sun shining through the mountains of the moon.
- **Diamond ring**: The very last bead.
- Second contact (C2), totality.



Baily's Beads & Diamond Ring







Progress of an eclipse, 2

- The corona, the shell of plasma around the sun.
- Solar prominences, streaks of burning gas extending from the photosphere through the corona.
- The Geminid meteor shower and Comet Erasmus
- Third contact (C3), end of totality.
- Fourth contact (C4), end of moon's contact.



Prominence and Corona







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Eclipse Lore I

- Christopher Columbus used the total lunar eclipse of 2/29/1504 to scare the natives of Jamaica into continuing to feed his crew (they had cut off his food after six months of cheating and theft). Mark Twain adapted this story in A Connecticut Yankee in King Arthur's Court.
- Muhammad, prophet of Islam, was born in the year of a solar eclipse; his son Ibrahim died 1/22/632 during an eclipse. Islamic theology does not accept these events as signs, positive or negative. Muhammad said "The sun and moon do not eclipse for the birth or death of any man. When you see them, offer prayer." Sahih al-Bukhari 1042



Eclipse Lore II

- Emperor Louis I ("The Pious"), son of Charlemagne, saw a solar eclipse on 5/5/840 and was so terrified by the omen that he died shortly afterwards.
- Nat Turner, antebellum Virginia preacher, planned a slave revolt but wanted a sign from God in confirmation. In 1831 he saw two solar eclipses, 2/12 annular and 8/7 total, and launched the Southampton Insurrection (aka Nat Turner's Rebellion). Hundreds died.
- According to tradition, Chinese astronomers Ho and Hi failed to predict the eclipse of 10/22/2137 BCE due to drunkenness and were beheaded for incompetence. Bad choreographers beware.



Eclipses and Jewish law

- Observant Jews say a blessing when eating, seeing a wise man, recovering from illness, getting bad news, etc.
 Is there a blessing for seeing an eclipse?
- The obvious choice is "oseh ma'aseh b'reishit"; praise to God for the works of creation, said upon seeing oceans, mountains, tornados, lightning, comets, shooting stars.
- But there is no blessing for an eclipse, which in the Talmud was considered an omen of evil, or trying times.
- Succah 29a gives the evil causes of eclipses, among them unprevented rape and two brothers killed together.



The Length of the Day

- We can calculate the location and time of eclipses precisely for a couple thousand years forward and back.
- We find, e.g., that a total solar eclipse of 720 BCE would have been visible in the western Atlantic.
- But in fact, historical records of Babylon (now Iraq) report that the eclipse was visible there, in the wrong place!
- Conclusion: The speed of the Earth's rotation (i.e. the length of the day) is changing, and in fact is slowing down by about 2 ms / 100 years.



Einstein Proven Correct

- Newton knew that light rays bend near big objects.
 General Relativity predicts twice as much bending.
- The biggest nearby object is the Sun, and even there the bend predicted by G.R. is only 1.75 arcseconds.
- When a star is near the Sun, the latter is too bright for the star to be visible—except during an eclipse!
- During an eclipse in 1919 the bend in the light from a star near the sun was measured and found to be in accordance with the G.R. prediction.



QUESTIONS?



Eclipse 201: Advanced

(Put questions in the chat, or just speak up!)

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Why not two per month?

- If the moon orbited the earth in the same plane that the earth orbits the sun (called the plane of the ecliptic) then we'd have one solar eclipse and one lunar eclipse each month.
- But the moon's orbit is tilted, so eclipses occur only when the moon crosses the ecliptic (called a node) at just the right time.



The Eclipse Season

Picture a stationary Earth, with the moon in tilted orbit, and the sun moving around the Earth(!) once per year.



Eclipses can occur only when sun and earth line up with a node, essentially twice per year. This time is called the **eclipse season**.



Eclipse Season, cont.

- The length of the eclipse season, about 34 days, depends on the sizes of the sun and moon. (If both were points, the eclipse season would be zero.)
- Every new moon during eclipse season yields a solar eclipse; every full moon yields a lunar eclipse.
- But the moon makes a full orbit in 28 days[*]! So every eclipse season has at least one solar and one lunar eclipse, and there can be a third (of either type). [*] synodic vs. draconic complication elided



Eclipse Season, cont.

- Eclipse seasons don't occur twice per year due to the regression of the lunar nodes; the nodes move with respect to the sun's position.
- Result: There are two eclipse seasons, not per year, but per eclipse year, which is about 347 days.
- Hence a calendar year can have (a piece of) a third eclipse season, enough to slip in one more eclipse.
- Bottom line: Every calendar year has at least 4 and at most 7 eclipses; with at most 5 of any one type.



The Saros Cycle

- The relative positions of earth, moon, and sun recur (almost) exactly every 18 years, 11 days, 8 hours; this period of time is called a saros.
- So for any eclipse, there's an (almost) identical eclipse 18 years, 11 days, and 8 hours later.
- The solar eclipses separated by this period form a group called a saros series. Today's eclipse is in Saros Series 142.



So, Chile/Argentina in 2038?

Eclipses in the same Saros Series differ because...

- ...the saros is 6585 days <u>and 8 hours</u>, so the earth's rotation pulls each eclipse about a third of the way farther around the world.
- ...the recurrence isn't exact, so the location of eclipses in a Saros Series progresses slightly, north to south or the reverse. The eclipses also change character as they progress, partial to total and back.



Progression of a Saros

- An even-numbered saros series starts with a partial eclipse near the South Pole and ends with one near the North Pole. For odd numbers: North to South.
- Today's eclipse is #23 of Series 142, which started with the partial eclipse of 4/17/1624 and will end with #72 on 6/5/2904. Don't wait up for me.
- #22 of this series was the eclipse of 12/4/2002, which was visible mostly in Africa and the Indian Ocean—that is, a third of the way around the world.



QUESTIONS?

