HOW A LEAP YEAR WORKS

TEJA TEPPALA

About me

- Teja Teppala
- Doctoral Candidate in Astronomy
- Studies star formation in low-mass galaxies

Any leap day babies in the house?

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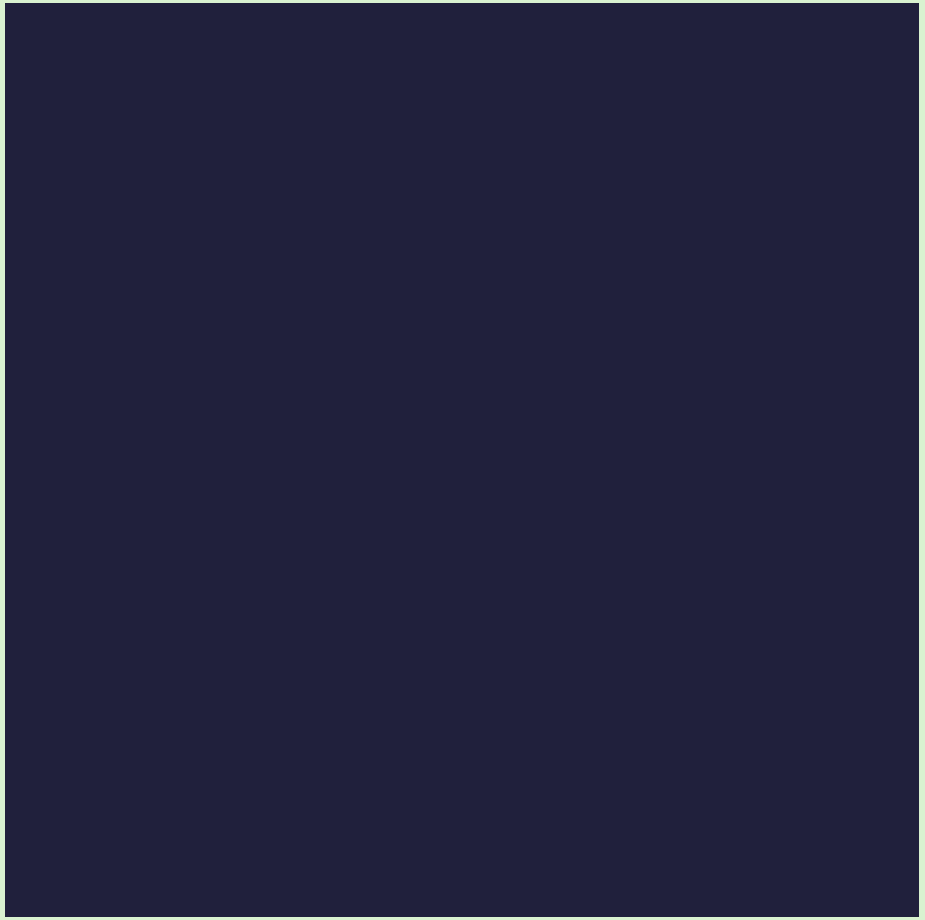
Chances are about one in 1461!

What is a year, anyway?



Different definitions of a year

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- Calendar year: 365 days (or 366 days in leap years)

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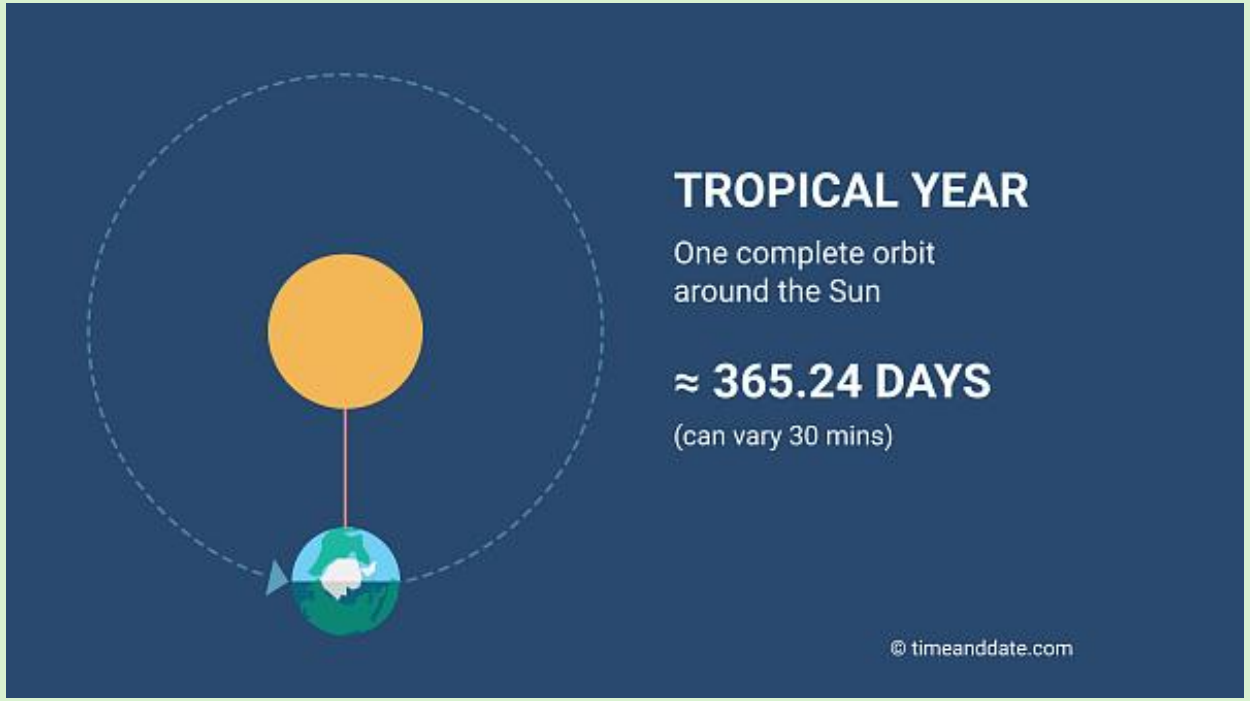
- Tropical year: time that the Sun takes to return to the same position in the sky.



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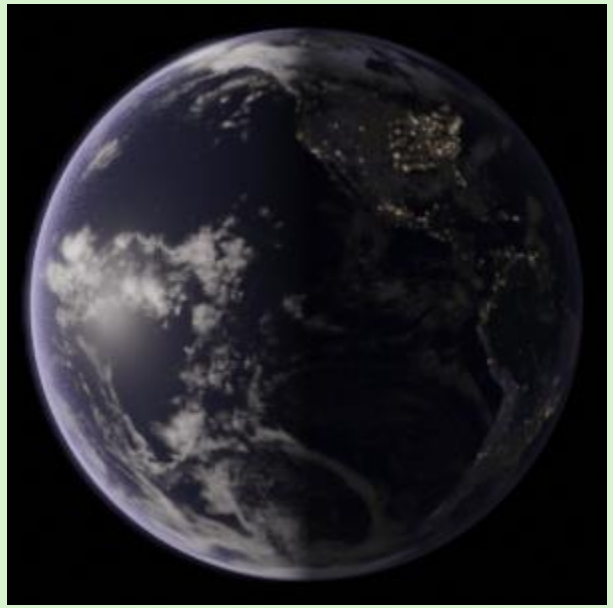
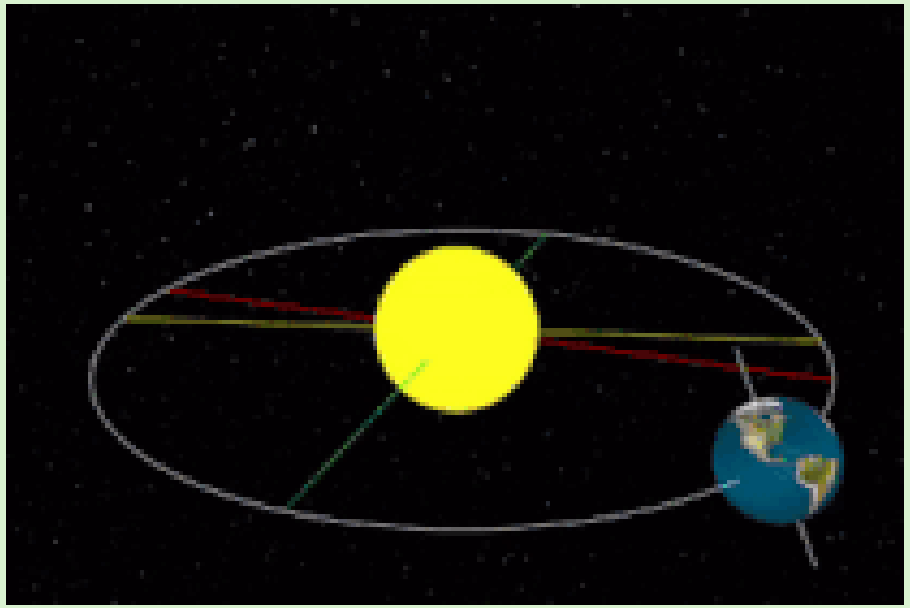
- The day/night cycle due to Earth's rotation, has nothing to do with the yearly cycle from Earth's revolution.





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- TBH, a day isn't exactly 24 hours long. But that's a story for another time.

Before we dive in, why do we have seasons?

Reason for seasons:

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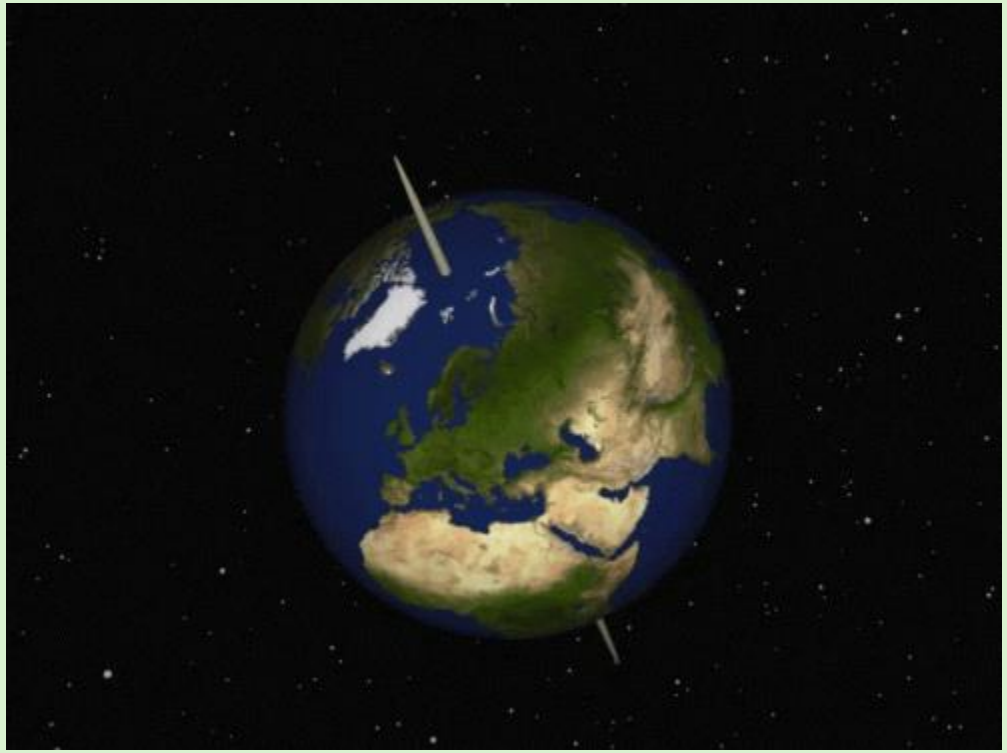
- Earth has seasons because something collided and caused the axial tilt.



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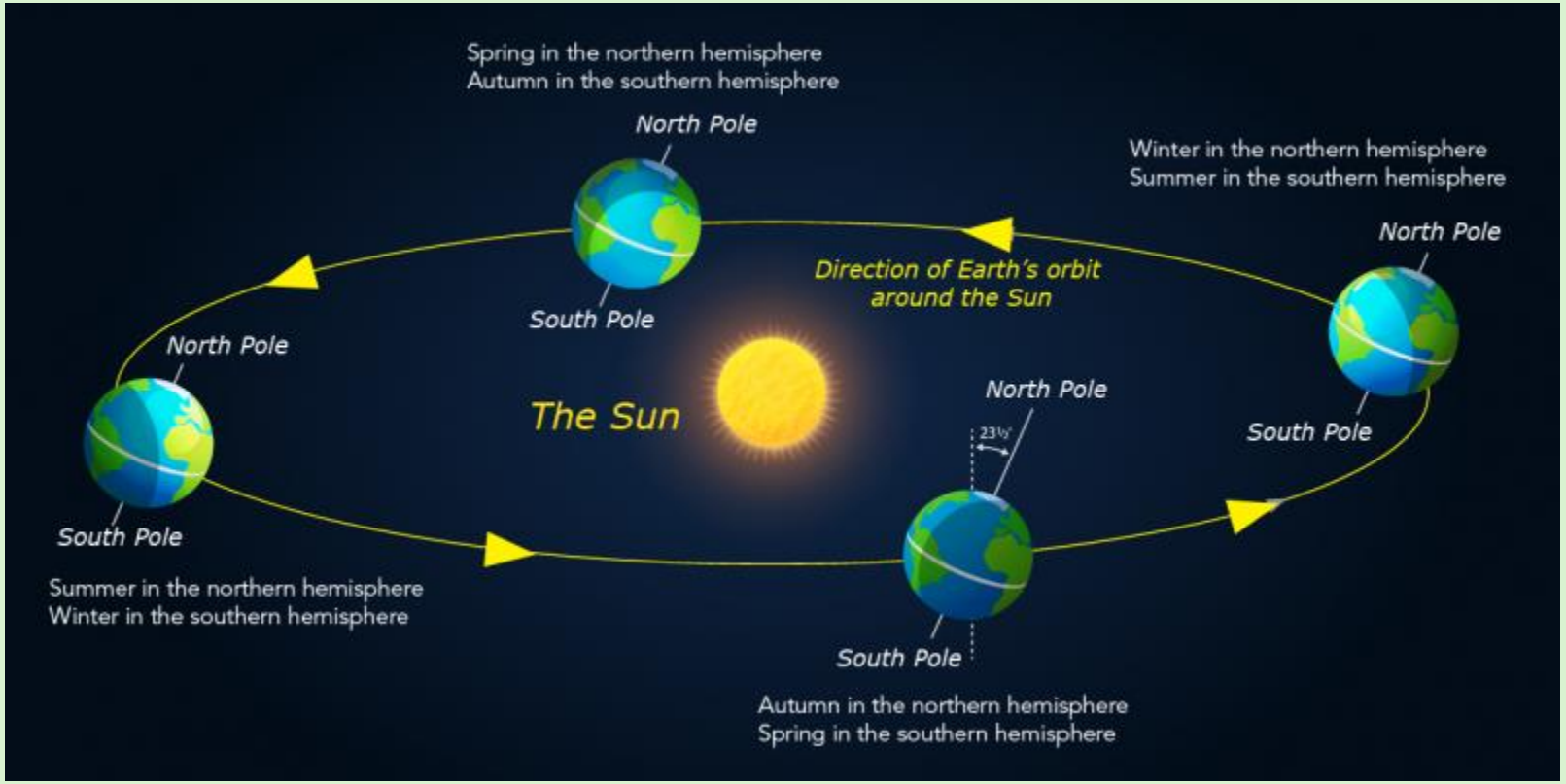

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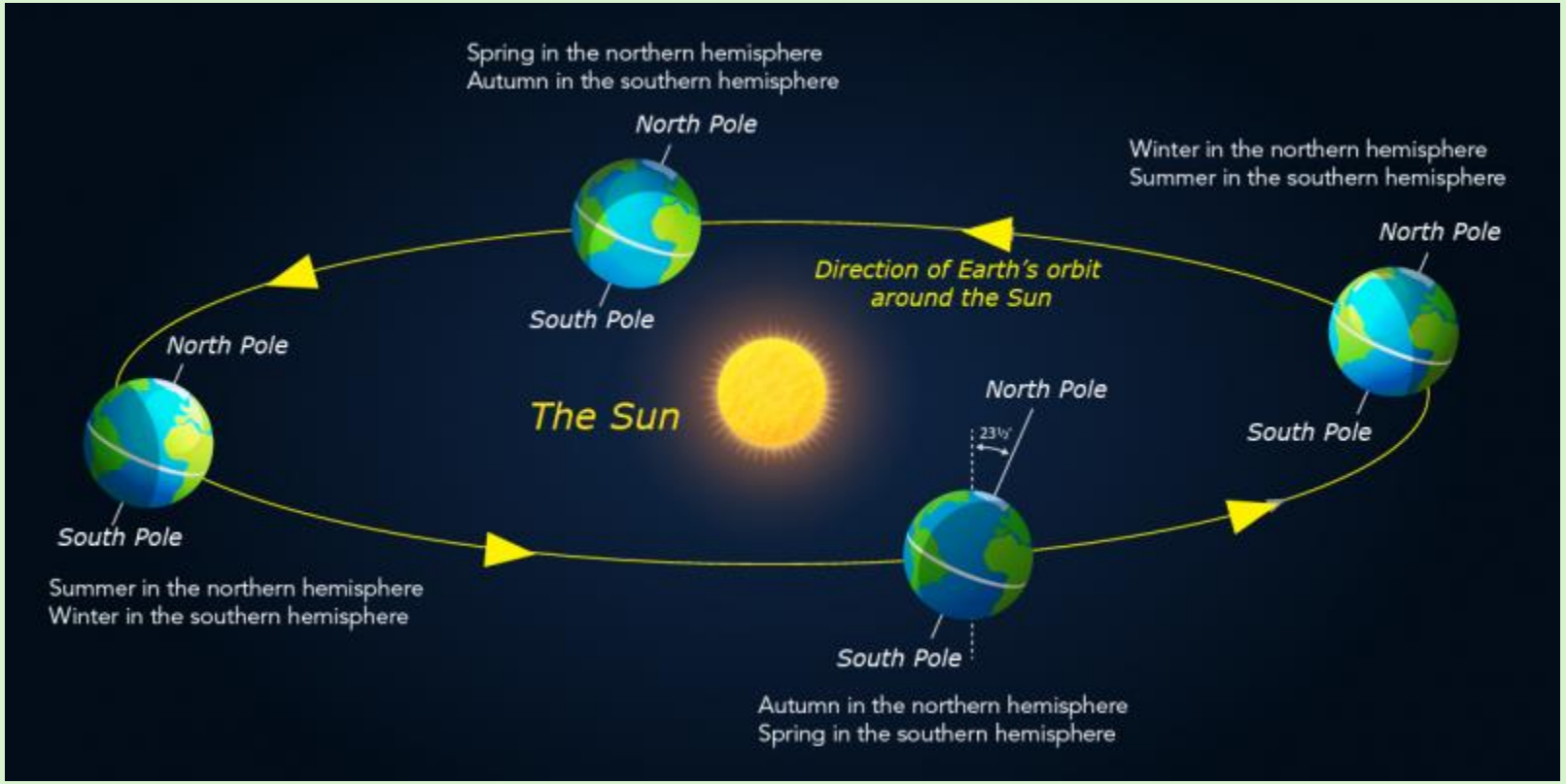

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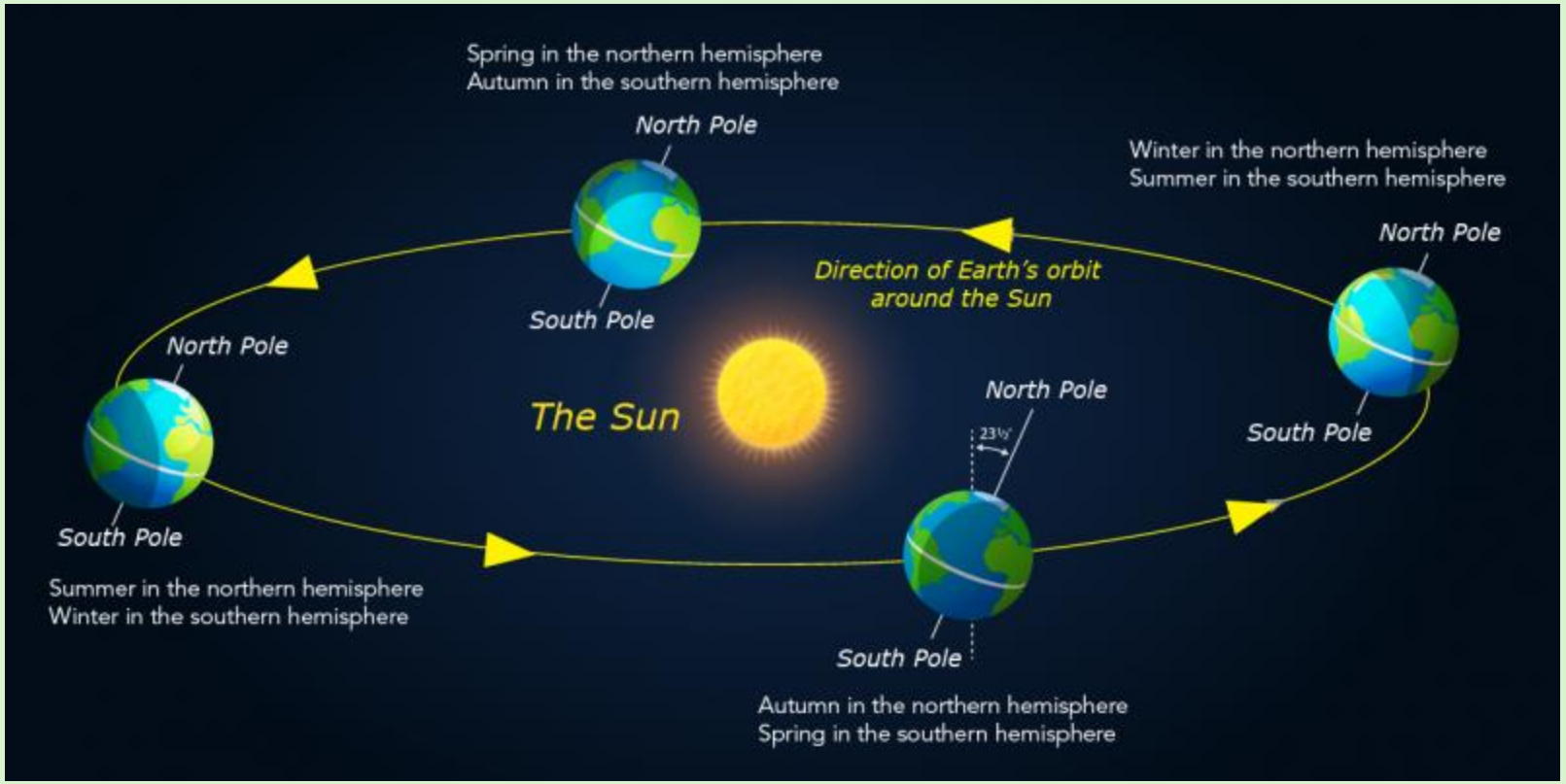
- **Seasons go out of sync!**



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- The extra 0. 24 days throws seasons off after a few years!

What happens if we use 365 days?

- Also, bad news for farmers!

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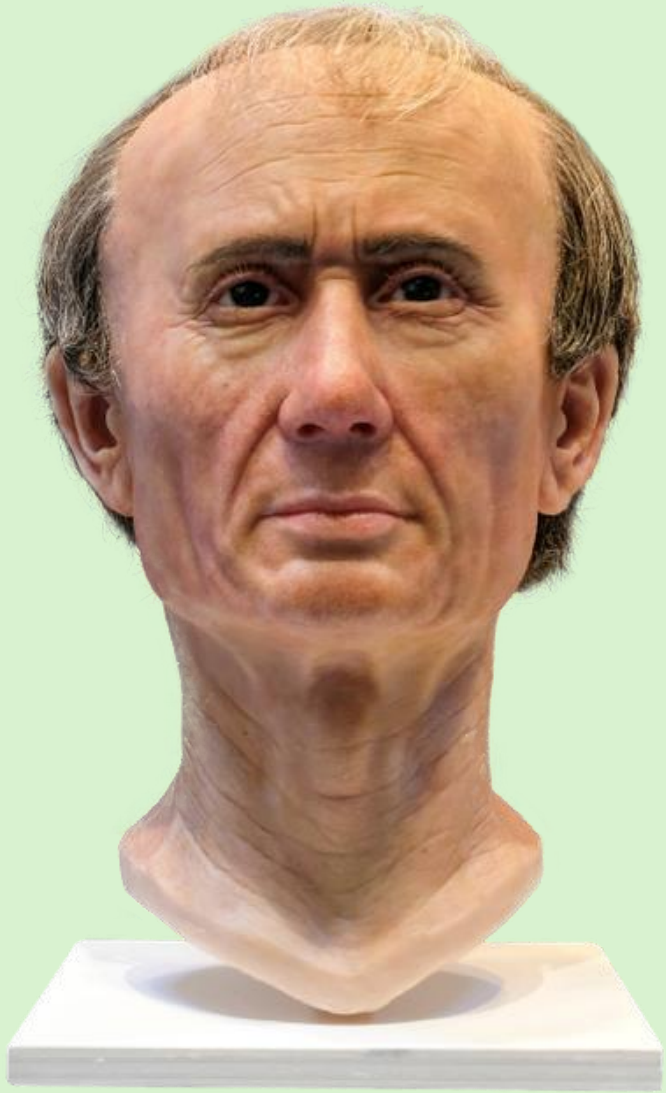

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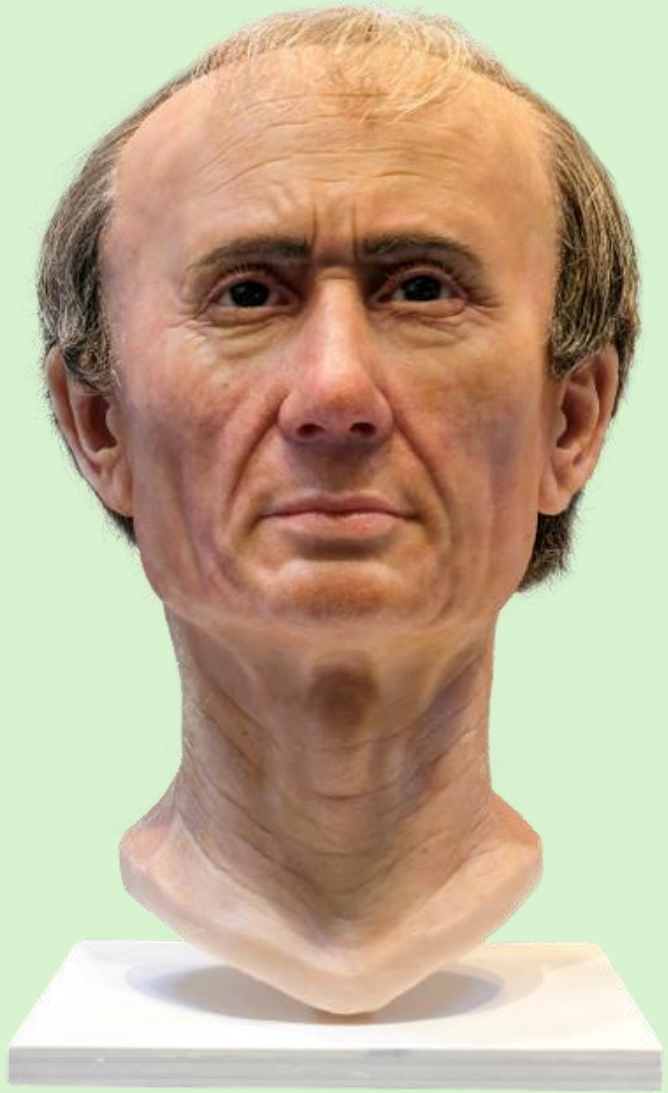

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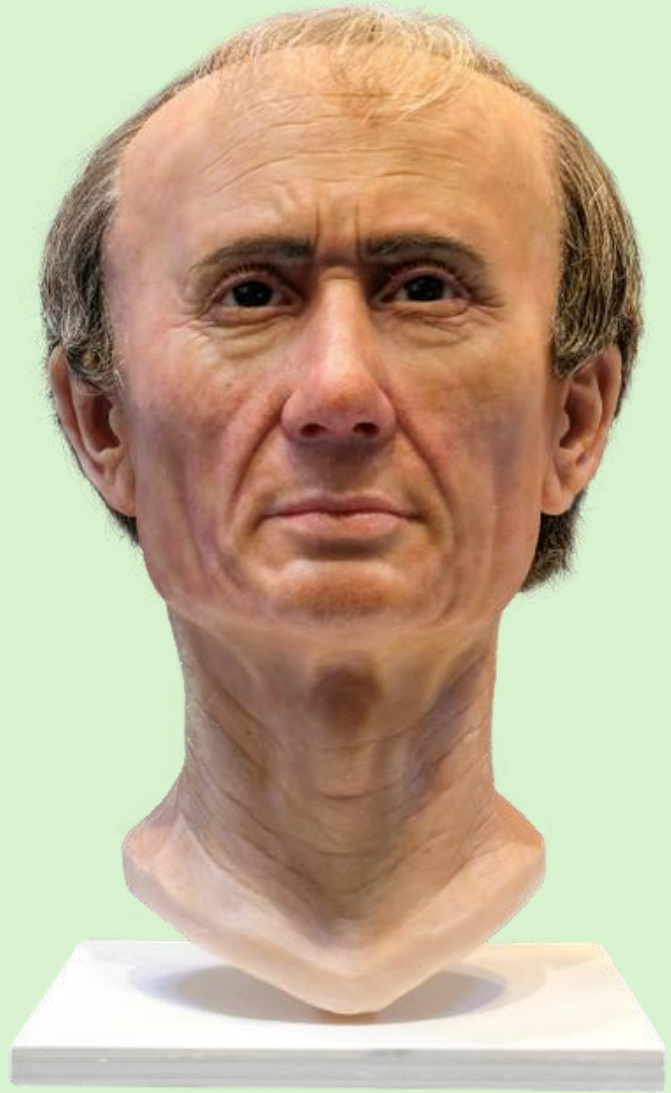
- Essentially adding it to the last month of the leap year.
- He also did a bunch of crazy stuff. .



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- He shifted the beginning of the year from March 1 to January 1!

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- That's why the 7th month (September) through the 10th month (December) are now the 9th through 12th months.

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- He also shifted the beginning of the year from March 1 to January 1!
- That's why the 7th month (September) through the 10th month (December) are now the 9th through 12th months.
- February, the 'original' 12th month, now gets to be the 2nd, and that's the reason why we have the leap day this month.

Problem solved?

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Acshually. .

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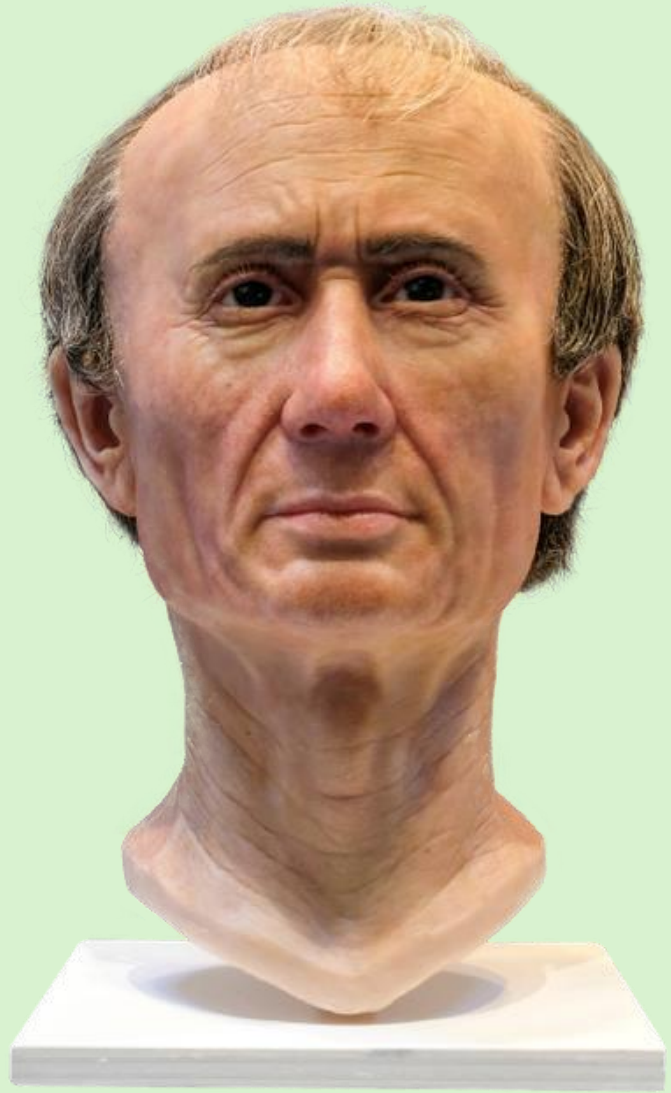
- Caesar's solution overcorrects.



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- That's 44 minutes, 56 seconds less than a day.
- This adds about 3.12 days every 400 years.

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- But at what cost?

New era begins. .

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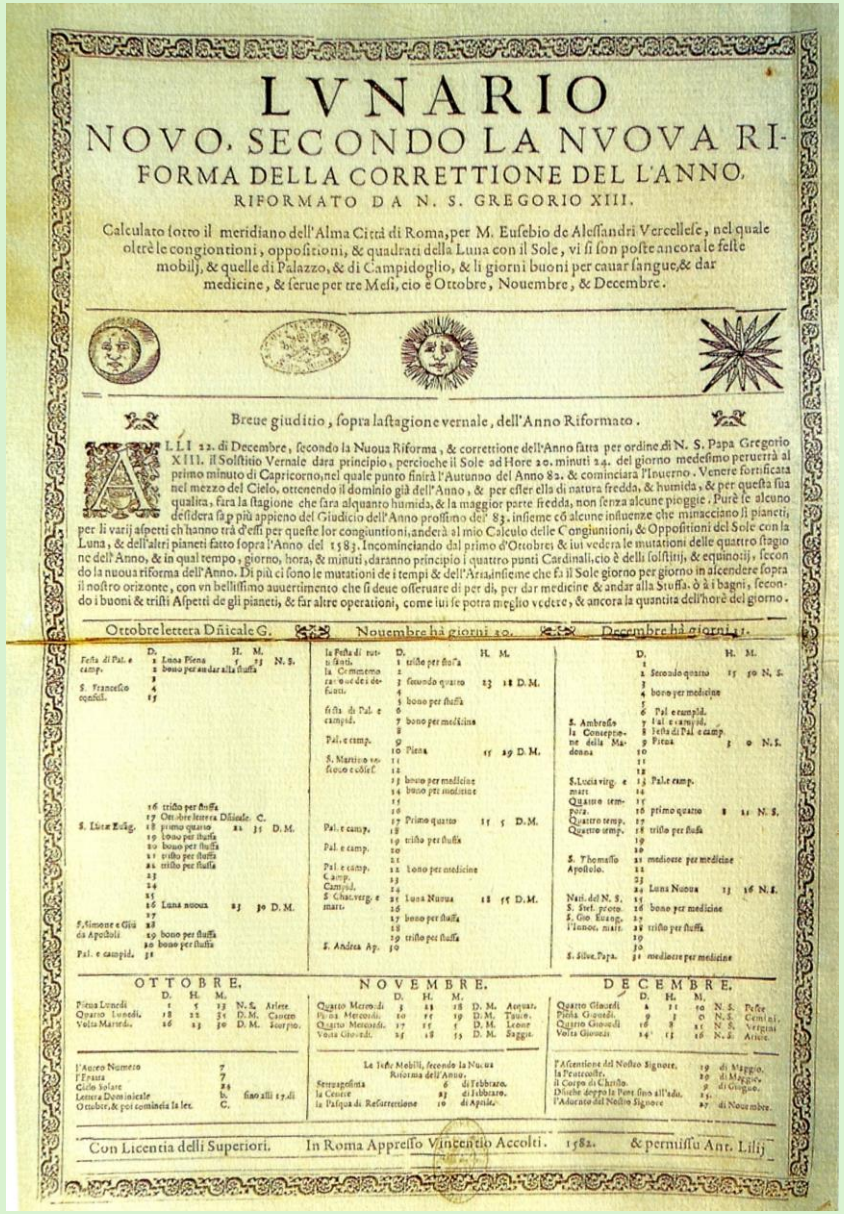

LVNARIO
NOVO, SECONDO LA NVOVA RI-
FORMA DELLA CORRETTIONE DEL L'ANNO,
RIFORMATO DA N. S. GREGORIO XIII.

Calculato sotto il meridiano dell'Alma Città di Roma, per M. Eusebio de Alessandri Vercellese, nel quale oltrè le congiontioni, oppositioni, & quadrati della Luna con il Sole, vi si son poste ancora le feste mobili, & quelle di Palazzo, & di Campidoglio, & li giorni buoni per cauar sangue, & dar medicine, & serue per tre Mesi, cio è Ottobre, Nouembre, & Decembre.

Breue giuditio, sopra lastagione vernale, dell'Anno Riformato.

ALLI 22. di Decembre, secondo la Nuoua Riforma, & correttione dell'Anno fatta per ordine di N. S. Papa Gregorio XIII. il Solstitio Vernale dara principio, perciochè il Sole ad Hore 20. minuti 24. del giorno medesimo peruerrà al primo minuto di Capricorno, nel quale punto finirà l'Autunno del Anno 82. & cominciara l'Inuerno. Venere fortificata nel mezzo del Cielo, ottenendo il dominio già dell'Anno, & per esser ella di natura fredda, & humida, & per questa sua qualita, fara la stagione che sara alquanto humida, & la maggior parte fredda, non senza alcune pioggie. Pure se alcuno desidera saper più appieno del Giudicio dell'Anno prossimo del 83. insieme cō alcune influenze che minacciano li pianeti, per li varij aspetti ch'hanno trà d'essi per queste lor congiuntioni, anderà al mio Calculo delle Congiuntioni, & Oppositioni del Sole con la Luna, & dell'altri pianeti fatto sopra l'Anno del 1583. Incominciando dal primo d'Ottobre, & iui vedera le mutationi delle quattro stagione dell'Anno, & in qual tempo, giorno, hora, & minuti, daranno principio i quattro punti Cardinali, cio è delli solstitij, & equinotij, secondo la nuoua riforma dell'Anno. Di più ci sono le mutationi de i tempi & dell'Aria, insieme che fa il Sole giorno per giorno in alcendere sopra il nostro orizonte, con vn bellissimo auuertimento che si deue osseruare di per dì, per dar medicine & andar alla Stufa, ò à i bagni, secondo i buoni & triſti Aſpetti de gli pianeti, & far altre operationi, come iui se potra meglio vedere, & ancora la quantita dell'hore del giorno.

Ottobre lettera Dñicale G. Nouembre hà giorni 30. Decembre hà giorni 31.

OTTOBRE.

	D.	H.	M.	
Festa di Pal. e camp.	1	Luna Piena	5	33 N. S.
	2	buono per andar alla stufa		
	3			
S. Francesco confess.	4			
	15			
	16	triſto per stufa		
	17	Ottobre lettera Dñicale. C.		
S. Luca Euag.	18	primo quarto	21	35 D.M.
	19	buono per stufa		
	20	buono per stufa		
	21	triſto per stufa		
	22	triſto per stufa		
	23			
	24			
	25			
	26	Luna nuoua	23	30 D.M.
	27			
S. Simone e Giuda Apostoli	28			
	29	buono per stufa		
	30	buono per stufa		
Pal. e campid.	31			

NOVEMBRE.

	D.	H.	M.	
la Festa di tutti i santi.	1	triſto per stufa		
la Commemo ratione de i defonti.	2			
	3	secondo quarto	23	18 D.M.
	4			
festa di Pal. e campid.	5	buono per stufa		
	6			
Pal. e camp.	7	buono per medicina		
	8			
S. Martino vescouo e confes.	9			
	10	Piena	15	29 D.M.
	11			
	12			
	13	buono per medicine		
	14	buono per medicine		
	15			
	16			
	17	Primo quarto	15	5 D.M.
Pal. e camp.	18			
	19	triſto per stufa		
Pal. e camp.	20			
	21			
Pal. e camp. Camp. Campid.	22	Luono per medicine		
	23			
	24			
S. Chaterug. e mart.	25	Luna Nuoua	18	15 D.M.
	26			
	27	buono per stufa		
	28			
	29	triſto per stufa		
S. Andrea Ap.	30			

DECEMBRE.

	D.	H.	M.	
	1			
	2	Secondo quarto	13	50 N. S.
	3			
	4	buono per medicine		
	5			
	6	Pal. e campid.		
S. Ambrosio	7	Pal. e campid.		
la Conceptione della Madonna	8	festa di Pal. e camp.		
	9	Piena	3	0 N.S.
	10			
	11			
	12			
S. Lucia virg. e mart.	13	Pal. e camp.		
	14			
Quatro tempi.	15			
	16	primo quarto	8	22 N. S.
Quatro temp.	17			
Quatro temp.	18	triſto per stufa		
	19			
	20			
S. Thomasso Apostolo.	21	mediocre per medicine		
	22			
	23			
	24	Luna Nuoua	13	36 N.S.
Nati. del N. S.	25			
S. Steſ. proto.	26	buono per medicine		
S. Gio Euang.	27			
l'Innoc. niati.	28	triſto per stufa		
	29			
	30			
S. Silue. Papa.	31	mediocre per medicine		

l'Aureo Numero	7		
l'Epacta	7		
Ciclo Solare	28		
Lettera Dominicale	b.	fino alli 17. di	
Ottobre, & poi comincia la let.	C.		

Le Feste Mobili, secondo la Nuoua Riforma dell'Anno.

Septuagesima	6	di Febbraro.
la Cenere	23	di Febbraro.
la Pasqua di Resurrettione	10	di Aprile.

l'Ascentione del Nostro Signore,	19	di Maggio.
la Pentecoste,	29	di Maggio.
il Corpo di Christo.	5	di Giugno.
Dilche dopo la Pent. fino all'Auo.	23.	
l'Aduento del Nostro Signore	27	di Nouembre.

Con Licentia delli Superiori. In Roma Appresso Vincentio Accolti. 1582. & permissu Ant. Lilij

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- How do we correct that?

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New formula:

- Remember the 3. 12 days added every 400 years?
- Rinse and repeat the same trick!
- They designated only certain hundred-year dates as leap years.
- Only hundred-year dates such as 1600, 2000, etc. which are divisible by 400 are leap years.
- Others, such as 1700, 1800, 1900, 2100, etc. are not!

Is it perfect?

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- Not really; but will work for a long time ~ 3333. 3 years.

More math! Why 3333. 3 years?

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Anyway. .

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- The average length of year becomes (291 x 366 + 909 x 365)/1,200 = 365. 2425 days.
- This gives an error of 365. 2425 – 365. 2422 = 0. 0003 days per year, or one day every 3,333. 3 years.

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- Current astronomers don't really care, it is up to the future astronomers to figure it out.

Questions?

April 8th Eclipse: ~94% in Columbia

Info from NASA:

Follow Laws Observatory:

LAWS_OBSERVATORY

LAWS OBSERVATORY

Thank you!

- Teja Teppala
- ttgbk@mail.missouri.edu

@_TEJA_T__

NASA Partner

ECLIPSE AMBASSADORS

How did Egyptian astronomers figure the length of Earth's orbit?

- Egyptians started out with a lunar calendar, based on Moon's phases.
- It was around 354 days long (loss of 11 days).
- Around 2500 B. C., they adopted a new "civil" calendar based upon astronomical observations of Sirius.
- Sirius appeared right before sunrise around the onset of Nile's flood.

How did Egyptian astronomers figure the length of Earth's orbit?

- They tried to correct it based on Sirius' reappearance during the next flooding.
- This ended up in a calendar year of 365 days; 12 months of 30 days each and a "13th month" of 5 days.
- Over time, they realized that Sirius rose a day late every 4 years.
- Thus, they figured that the actual year is a quarter day longer than 365 days.