

A History of Science in Latin America (INTD290): Unit 1.2

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Outline

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Comparative medical treatments - chapter 1 content.

Chapter 2 content

1. Mining and agriculture in Nueva España
2. Construction of scientific communities
3. The formation of scientific literature and community,
importation of scientific texts
4. Catholic religious orders in Latin America
5. Galileo, Kepler, and the Heliocentric system of the world

Activities

1. Timelines of discoveries and development
2. Geographical illustrations with Google Earth
3. Digital Storytelling on cosmic rays and the solar wind

More on Literary Societies and Journals

More on Literary Societies and Journals

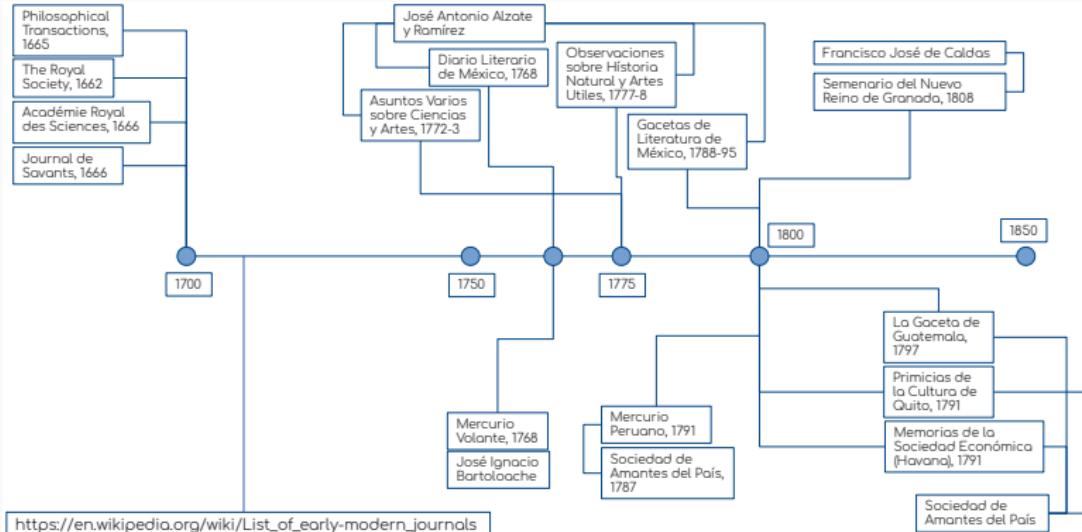


Figure 1: A visualization of scientific journals of the 18th Century Latin American society. Note the prevalence of Societies of Friends of the Country, versus Royal Societies. Note also the gap between 1700-1750. For a complete list of journals in the gap, see the link at lower left.

More on Literary Societies and Journals

1. Friends of the Country versus Royal Society
2. Alzate, Bartolache (Mexico)
3. Other journals not shown: *Gacetas de Caracas, 1808*, *Semenario de Agricultura, Industria y Comercio, Buenos Aires, 1802*, *O Patriota, 1813-1814*
4. Mining processes debated in these journals, the patio process versus the Born process
 - Fausto de Elhúyar (Spain), Baron von Nordenflicht (Sweden)
 - José Antonio Alzate (New Spain) wrote in *Observaciones* in 1787 that Álvaro Alonso Barba discovered the “Born method” in 1640. The Creoles noted that the Born method was not as efficient in this situation.

More on Literary Societies and Journals

The results of an intriguing physics experiment were first published in **Gacetas de Literatura**, by José Antonio Alzate y Ramírez, José Francisco Dimas Rangel, and Antonio de León y Gama. An article summarizing their results:

M. P. Ramos-Lara *Contribuciones de astrónomos mexicanos al estudio de auroras boreales de baja latitud entre 1789 y 1791.*
Revista Mexicana de Física E **18** (1) 156-167

<https://youtu.be/czMh3BnHFHQ>

<https://xkcd.com/2004/>

More on Literary Societies and Journals

José Antonio Alzate y Ramírez

1. Catholic priest, and descended from Juana Inéz de La Cruz (protofeminist Catholic nun, writer, intellectual - see the work of Octavio Paz).
2. Meteorology, Physics, Astronomy, Mathematics, Indigenous history
3. Corresponding member of French and Spanish Academies of Science



- Wrote 30 books. One of them: *Observación del paso de Venus por el disco del Sol.* (1770)
- 1885: La Sociedad Científica Antonio Alzate, later became The National Academy of Sciences (Mexico)

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Antonio de León y Gama

1. Lawyer who worked at the *Real Audiencia de México*
2. Astronomer, anthropologist, writer
3. Discovered two important anthropological items:
4. (Projects?)



Figure 2: (Top) Leon

- La Coatlicue - An intact statue of the “mother of the Gods,” including Huitzilopochtli.
- La Piedra del Sol - A calendar stone that led to a modern understanding of how the Aztec calendar worked.

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Figure 3: The colors of the aurora correspond to solar electrons interacting with various gases in the atmosphere.

1. European (French) scientists had established a lower limit on the latitude auroras could be observed: 35 degrees North of the Equator.
2. The Mexican scientists observed the aurora at 16.8 degrees North
3. Like modern scientists, they did not stop at observation but attempted to explain with a theoretical model

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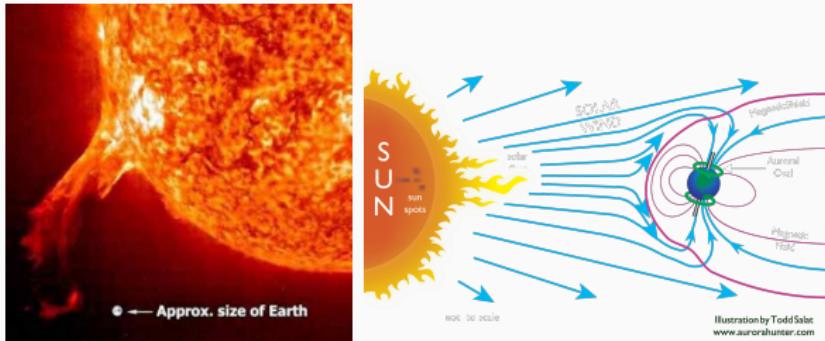


Figure 4: (Left) The size of a coronal mass ejection is several times larger than Earth. (Right) The solar wind is charged, meaning it has a magnetic field, which adds to that of the Earth.

- Auroras are pretty, but they will kill you in your face
- The three Mexican scientists noted that auroras were correlated with sun spots and provided historical data for future scientists
- Increase in sun spot size, low altitude aurora

More on Literary Societies and Journals

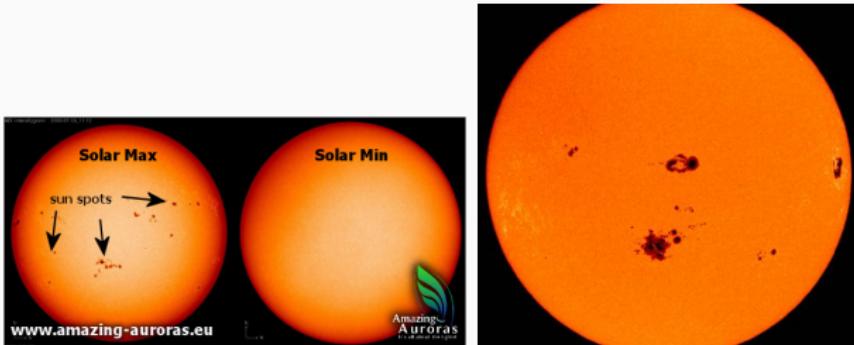


Figure 5: The colors of the aurora correspond to solar electrons interacting with various gases in the atmosphere.

- Sun spots are concentrations of magnetic field that deflect charged particle conduction
- Cools the area, making it darker
- Sun spots come in pairs (magnetic fields)

More on Literary Societies and Journals

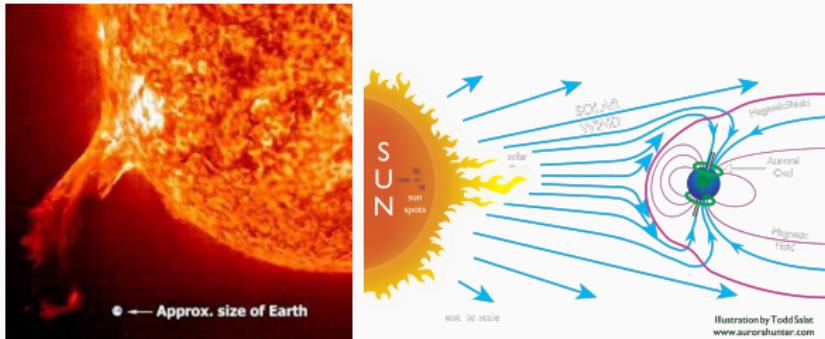


Figure 6: (Left) The size of a coronal mass ejection is several times larger than Earth. (Right) The solar wind is charged, meaning it has a magnetic field, which adds to that of the Earth.

- The scientists of New Spain deduced the altitude of the aurora phenomenon
- Predicted where they could be observed in other continents, got some of them right

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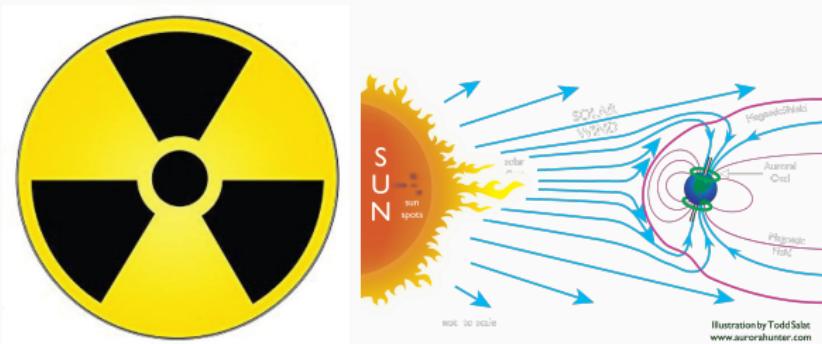


Figure 7: (Left) The size of a coronal mass ejection is several times larger than Earth. (Right) The solar wind is charged, meaning it has a magnetic field, which adds to that of the Earth.

- They formulated a theory of how the light was produced, and designed an apparatus
- Using the apparatus, **they reproduced some aurora properties in the lab.**

More on Literary Societies and Journals

Noteworthy for the history of science:

De tres modelos originales de auroras boreales formulados en el continente americano hasta el siglo XVIII, dos de ellos fueron planteados en Nueva España y uno en Estados Unidos de Norteamérica [5].

(Citing from paper above). The results generated books, articles, and in particular, articles published in the journal founded by Alzate: *Gacetas de Literatura*.

Review graphs from paper.

More on Mexican Astronomers

More on Mexican Astronomers

Where were the auroras?

1. Sir Edmond Halley thought that the magnetized matter was radiating from the poles of the Earth. This was a valid hypothesis because *no one had ever been to the poles.*
2. Benjamin Franklin thought that the origin was terrestrial electricity.
3. Jean-Jacques Dortous de Mairan: matter from the Sun's atmosphere, and believed it was *above* our atmosphere

More on Mexican Astronomers

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More on Mexican Astronomers

Where were the auroras observable?

1. Mairan and León y Gama thought it was only observable along certain angles
 - Mairan associated it with Zodiacal light, León y Gama thought it was associated with the *ether*.
 - Alzate y Ramírez collected observations from multiple cities and locations to determine the geometry of the ring (radius of ≈ 4000 km).
2. Alzate y Ramírez predicted the aurora would have been observed in other countries, including Spain, and as far away as Russia. Spanish observations proved him right.
3. León y Gama located a reference suggesting indigenous observations of auroras in 1602 (Juan de Torquemada).

More on Mexican Astronomers

What was an aurora?

1. Alzate y Ramírez linked observations from many cities to one event, rather than treating them as individual events
2. León y Gama noted that the same aurora could present differently in different locations due to variation in local conditions: (1) one event many observations (2) size variation (regular, grande etc.) (3) local conditions could change the form and colors ... *encendida*.
3. León y Gama concluded that they were higher than the atmosphere because he thought the atmosphere ended far lower than it does, and gave examples for all the phenomena we know and the typical altitude above sea level
4. León y Gama thus decided that sense there appeared to be a correlation with the Moon's phase, that it was the Moon exciting the ether, though our atmosphere determines the colors. Altitude calculation: 460 - 512 km

More on Mexican Astronomers

What was an aurora?

1. Experiments of José Francisco Dimas Rangel
 - Watchmaker, engineer
 - Invited (along with Alzate and León y Gama) to the court of the viceroy for scientific meetings
 - These meetings were organized by *Joaquín Velázquez Cárdenas de León* ... Astronomer who with d'Auteroche recorded Venus transits in Baja California. Cárdenas de León was also director of Royal Tribunal of Minerals
 - Dimas Rangel occasionally published anonymously (like others)
 - **Presented an experimental design to replicate effects of aurora**
 - It was basically a fluorescent light (current through rarified gas in a glass tube) ... before 1800 ...
 - Balmer transition (red like aurora)

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Transition to Expeditions and Exploration

More on Mexican Astronomers

1. The Mexican astronomers were dealing with uncertainties in angular observations.
2. They were also dealing with cartographic uncertainties (see board).
3. Could get anywhere from infinity height or 100 km for altitude of aurora.
4. **How are latitudes and longitudes measured?** How do you determine how far away an object is located, when you live in the 1700s and 1800s?