

Midterm - INTD262

Dr. Jordan Hanson - Whittier College Dept. of Physics and Astronomy

October 18, 2024

1 Unit 0

1. Offer some reasons why the Spaniards created the *virreynatos* of Nueva España and Perú in their respective locations, with Tenochtitlan and Lima as capital cities.

Economic Significance ,Tencochotila was the heart of the Aztec Empire , they were rich in resources and trade networks.
Infrastructure and resources, these cities has existing infrature and resources that the Spainards could use and expand.

2. Was there a link between the introduction of capitalism and the growth of scientific activity in Latin America, or did the growth of modern science precede capitalism?

Yes there was a link. It would influence the Enlightenment, in the 18th century by helping new ideas of science spread and help it grow.

3. Given the definition of *peripheral* scientific activity in the Introduction, can you give an example of the creating and transmission of scientific results from the periphery to the center of science?

Jose Antonio Alzate and Ramirez would make an observation in Mexico regarding the Auroa in 1789 and share his observation with european scientist.

4. Give some examples of *pseudo-scientific* beliefs regarding mythical places the colonials sought in the New World.

El Dorado: The legendary city of gold that many explorers, including Sir alter Raleigh sought in south America .
Fountain of Youth: A mythical spring that supposedly restored the youth of anyone who drank from it.

5. Multiple Choice - Nahua scientific activity, first period

- (a) Which of the following were media through which inhabitants of the Mexica empire recorded scientific observations about the natural world?

- A: *Axolotl* (codices) and *huitzitzilin* (paintings, stelae)
- B: *Amoxtl* (codices) and *tlacuilo* (paintings, stelae)
- C: *Tomatl* (plume, writing tool) and *altepetl* (city-state)
- D: *Quetzal* (plume, writing tool) and *huitzitzilin* (city-state)

- (b) Using information from *Historia natural y moral de las Indias* (de Acosta), *Historia general y natural de las Indias* (Oviedo), *Décadas del Nuevo Mundo* (Anglería), *Historia de Nueva España* (Hernández), match the European story to the indigenous story or piece of knowledge.

- (1): Ponce de León and the Fountain of Youth
- (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm.
- (3): "A fountain running with hot water and as the water runs it turns to stone."
- (4): "fish that as they leave the water turn into butterflies."
- (5): "...a monstrous animal, with the face of a fox, a tail of a cercopithecus, ears of a bat, human hands, and feet of a monkey." Carries young on the belly.

-
- A: A flying fish 4
 - B: A condor 2
 - C: A mercury mine 3
 - D: The belief about a certain river among the Lucayo and Carib indigenous 1
 - E: The Mexican opossum 5

6. Nahua scientific activity, second period

- (a) Father Bernardino de Sahagún translates from Nahuatl a description of a “tiger” that the indigenous say can do the following: (a) see small things even though there is fog or darkness (b) creates sounds “through the air” to intimidate hunters. What does this writing tell us about the Nahua understanding of physics?

That physics had to do with optic (SOUND)

- (b) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality?

Due to hibernation . They “died” in the winter, they “revive” in the spring

7. Suppose the following statement is given: “If someone was born between 1945 and 1991, then they have Strontium-90 in their bones.” Which of the following statements is *deductively valid*?

- Adam was born in 1963. Therefore, Adam has Strontium-90 in his bones
- Eve has Strontium-90 in her bones. Therefore, Eve was born between 1945 and 1991.

8. Consider the following passage from Chapter 1 of *The Scientific Attitude*:

In 1981, the state of Arkansas passed Act 590, which required that public school teachers give “balanced treatment” to “creation science” and “evolution science” in the biology classroom. It is clear from the act that religious reasons were not to be offered as support for the truth of creation science, for this would violate federal law. Instead, the curriculum was expected to concentrate only on the “scientific evidence” for creation science. But was there any? And, how precisely was creation science different from creationism?

Explain the arguments used in court to thwart Act 590 the following year.

The arguments used afterwards were focused on the distinction between science and religion . Some key point were lack of scientific credibility and educational integrity.

9. Thomas Kuhn wrote a famous book entitled *The Structure of Scientific Revolutions* (1962). Rather than describing science as a global accumulation of progress, he argues that, sociologically, scientists move between periods of “puzzle-solving” within an accepted framework and revolution triggered by unavoidable experimental anomalies. (a) Give one example of a scientific revolution, and note the anomaly. (b) Do you think that the colonization of Nueva España triggered a scientific revolution?

a) Newtonian mechanics to Einstein’s theory of relativity. The anomaly that triggered this revolution was the observation of the perihelion precession of Mercury’s orbit.

b) The colonization of Nueva España did contribute to a scientific revolution. They would use the fields in botany, zoology, and anthropology.

10. Fill in Tab. 1 below, using Fig. 1.

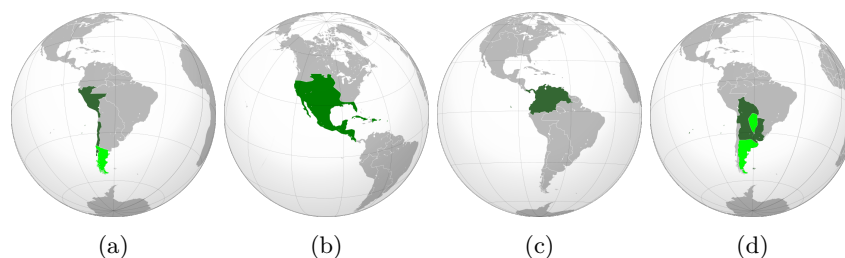


Figure 1: Maps depicting *virreinos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	<i>Virreinato</i>	Capital
B	<i>Nueva España</i>	Text
C	<i>Nueva Granada</i>	
D	<i>Río de la Plata</i>	
A	<i>Perú</i>	

Table 1: Fill in the missing information.

11. Consider the library of José Ignacio Bartolache. (a) What does the distribution of texts in this library tell us about the scientific attitude of Latin Americans in the 18th Century? (b) What other scientific items did Bartolache own, and what clues does this add to our picture of the scientific attitude in that time and place? (c) Considering these collections were built before 1760, draw a comparison to the state of science in the American colonies (later the United States).

A) It reveals that Latin Americans in the 18th Century were highly engaged with contemporary scientific thought.

B) He owned telescopes, microscopes, and barometers

(C) Benjamin Franklin focused more on practical application of science for daily life and industry

2 Unit 1

1. In Chapter 2 of *The Scientific Attitude*, we encounter the following quote:

Samir Okasha recounts the example of John Couch Adams and Urbain Le Verrier ... they were working (independently) within the Newtonian paradigm and noticed a slight perturbation in the orbit of the planet Uranus.

Newton's Law of Gravity predicts perfectly elliptical orbits for the planets, with no perturbations. Was the law of gravity therefore *falsified*? What solved the problem in the end?

It was not falsified the discovery of Neptune in 1846 confirm the predictions and resolve the issue with Uranus's orbits

2. **Bode's Law** was an attempted mathematical explanation of the planetary orbits. Bode's sequence was the pattern 0, 3, 6, 12, 24, ..., plus 4 to each, then divide the sequence by 10. The result is 0.4, 0.7, 1.0, 1.6, 2.8, 5.2, 10.0, 19.6, 38.8, 77.2, At the time (1772), the radii of the planets from the Sun were 0.387, 0.723, 1.0, 1.524, 5.203, 9.539. Nine years later, Uranus was discovered at 19.18. Twenty years later, the asteroid belt between Mars and Jupiter was discovered at 2.77. Did Bode's Law become a scientific fact because it fit the data?

It did not become a scientific fact because it fit the data, it provided a pattern that would match the distance of the known planets from the sun. It was more of an empirical rule. The discovery of Uranus and the asteroid belt seemed to support Bode's Law.

3. In 1761, Judge Francisco Javier Gamboa created a set of legal and scientific studies that were meant to reform the mining industry, to make it more efficient. Recall some scientific results that he shared within his *Comentarios a las ordenanzas de minas*. What chemicometallurgical technique, important for ore extraction, did he share with The Crown? What institutions did he suggest creating?

He shared chemicometallurgical technique, he would use this for the process with mercury. It was essential for effectively extracting silver from ores

4. *El Real Seminario de Minería* was created by Joaquín Velázquez de León, Fausto de Elhúyar, and others. However, several factors might have driven it to bankruptcy. Describe the Mexican efforts to preserve it.

Mexican efforts to preserve *El Real Seminario de Minería* included government support and reforms. The institution received financial aid from the Mexican government, and efforts were made to modernize its curriculum and facilities. Prominent figures in Mexican science and industry advocated for its importance, helping to secure its place in the country's educational and industrial development.

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*?

Empirical evidence and Skepticism

6. Recall the story of Ignaz Semmelweis and antiseptic handwashing in maternity wards. Discuss how the scientific attitude was applied in this situation.

Ignaz Semmelweis applied the scientific attitude in his situation by observing a problem (high mortality rates in maternity wards), forming a hypothesis (infection was being transferred by medical students), and conducting experiments (introducing handwashing with chlorinated lime).

7. Recall the story of the false discovery of cold fusion. (a) Discuss how the scientific attitude was not applied in this situation. (b) Now select a piece of science from Latin American history that we have encountered thus far, and apply the criteria of the scientific attitude to it.

(a) The false discovery of cold fusion by Martin Fleischmann and Stanley Pons in 1989 is an example where the scientific attitude was not properly applied. They announced their findings through a press conference before their results were peer-reviewed and replicated by other scientists

(b) Consider the observations made by José Antonio Alzate y Ramírez on the aurora in 1789. Applying the scientific attitude to his work, we see that Alzate y Ramírez followed a systematic approach: he closely documented his observations, shared his findings with the scientific community, and invited peer review and discussion.

3 Unit 2

1. (a) In what viceroyalty (Fig. 1) was the city of Santa Fe de Bogotá? (b) Discuss the scientific implications of the “half century-long polemic on Copernican theories, which started in 1773 between José Celestino Mutis and the Dominican Congregation of Santa Fe de Bogotá. (c) In 1783, the Expedición Botánica began in Santa Fe. What were some of its goals and achievements?

(a) Nueva Granada.

(b) The half century-long polemic on Copernican theories that started in 1773 between José Celestino Mutis and the Dominican Congregation of Santa Fe de Bogotá had significant scientific implications. Mutis, a proponent of the heliocentric model, faced opposition from the Dominican Congregation, which upheld the geocentric model. This debate highlighted the tension between emerging scientific ideas and traditional religious beliefs, ultimately contributing to the gradual acceptance of Copernican theories in the region and fostering a more open scientific discourse.

(c) The Expedición Botánica, which began in Santa Fe in 1783, aimed to catalog and study the flora of New Granada. Some of its goals included identifying useful plants for medicine and agriculture, understanding the region's biodiversity, and advancing scientific knowledge. Achievements of the expedition included the extensive documentation of plant species, the creation of detailed botanical illustrations, and the establishment of a foundation for future botanical research in Latin America.

2. (a) In what viceroyalty (Fig. 1) was the city of Caracas? (b) In 1767, the Jesuit order was expelled from the Spanish colonies. The Dominican order recovered authority over some colleges and universities. What was the implication for science?

A) Nueva Granada

B) The expulsion of the Jesuit order from the Spanish colonies in 1767 had significant implications for science. The Jesuits were known for their contributions to education and scientific research, so their expulsion led to a temporary decline in scientific activities and educational standards. When the Dominican order took over some colleges and universities, there was a shift in the focus of education. The Dominicans were more conservative and less inclined towards the progressive scientific methods the Jesuits had promoted.

3. What scientific publication was created by José Celestino Mutis?

José Celestino Mutis created the scientific publication called “Flora de Bogotá” or “Flora of New Granada.” This monumental work documented a vast number of plant species from the region and is considered one of the most important contributions to botany in Latin America.

4. Evaluate the logical truth of this claim: “anti-vaccination campaigns do not have the scientific attitude, therefore these are not scientific endeavors.”

Anti-vaccination campaigns generally do not adhere to the principles of the scientific attitude. Since they do not follow the scientific method or embrace empirical evidence, it is reasonable to conclude that they are not scientific endeavors.

5. Discuss one example we have encountered from our scientific history that should count as science, even though it has not traditionally been considered scientific.

One example from scientific history that should count as science, even though it has not traditionally been considered scientific, is the work of indigenous knowledge systems. Indigenous peoples have long observed natural phenomena and developed sophisticated understandings of ecology, biology, and astronomy through their lived experiences and oral traditions. For instance, many indigenous communities have detailed knowledge of plant properties and uses, which they have used for medicinal purposes for centuries. This knowledge is often passed down through generations and involves careful observation, experimentation, and documentation, much like the scientific method. Despite not being recognized within the framework of Western science, these knowledge systems are rigorous and empirical. They contribute valuable insights and have practical applications that align with scientific principles.

6. In Chapter 3 of *Science in Latin America*, we encounter the following quote:

La Universidad Gregoriana in Quito alone had “seventy-one foreign professors teaching at the university ... Native professors were twenty-one, of whom five were from Loja, four from Quito, three from Guayas, three from Cuenca, three from Riobamba, two from Ibarra, and one from Ambato.” ... As a consequence, it is not strange that in a center of cultural ferment such as Quito, intellectual Jesuits were most closely linked to the Franco-Spanish geodetic mission directed by La Condamine and Jorge Juan.

- (a) What scientific transition began to take place as a result of the interaction between foreign and Ecuadorian professors? (b) What can we infer about the ratio of the native professors at the university? (c) Consider Father Fransisco Javier Aguilar, who taught physics and mathematics at Universidad Gregoriana. He taught no less than five world systems, and focused on three: Ptolemaic, Copernican, and Tychonic. What distinguished these?

(a) The interaction between foreign and Ecuadorian professors at La Universidad Gregoriana in Quito led to a significant scientific transition. This collaboration facilitated the exchange of ideas and knowledge, promoting a more global perspective in scientific education and research.

(b) From the provided quote, we can infer that the ratio of native professors to foreign professors at the university was quite low. Specifically, there were seventy-one foreign professors compared to twenty-one native professors. This indicates that the majority of the teaching staff were foreigners, highlighting the influence of international academics on the local educational system.

(c) These distinctions reflect the evolution of astronomical theories and the shift from a geocentric to a heliocentric understanding of the universe.

7. In 1767, Mutis published *Reflexiones sobre el sistema tycónico*. (a) What were the main points of this publication? (b) Was it considered controversial?

The main points of his publication included arguments in favor of the Copernican heliocentric model, emphasizing the need for scientific progress and the use of observational data to support astronomical theories. It was considered controversial.

8. When Joaquín Velázquez de León and José de Gálvez arrived in Baja California, they remained there for three years. (a) What types of measurements did they make? (b) How did this improve local knowledge of Nueva España? (c) Velázquez de León communicated with Chappe d’Auteroche that he would help with the Venus transit measurements, and d’Auteroche suggested that Velázquez de León remain in Real de Santa Ana, while

d'Aueroche would work in San José del Cabo. What happened as a result?

- (a) Joaquín Velázquez de León and José de Gálvez conducted various types of measurements in Baja California, including geographical, cartographical, and astronomical studies
(b) These measurements significantly improved local knowledge of Nueva España by providing more accurate and detailed maps of the region, as well as valuable information about its natural resources.
(c) Velázquez de León communicated with Chappe d'Aueroche to assist with the Venus transit measurements. Chappe d'Aueroche suggested that Velázquez de León remain in Real de Santa Ana to conduct these observations, which allowed for important international scientific collaboration and contributed to a better understanding of this astronomical event.

9. What was notable about the explorations of José Sanchez Labrador?

José Sanchez Labrador was a notable Jesuit missionary and explorer in South America during the 18th century. His explorations were particularly significant because he conducted extensive studies of the natural history, geography, and ethnography of the regions he visited, including parts of Paraguay, Uruguay, and Argentina. He closely documented the flora, fauna, and indigenous cultures, providing valuable insights and detailed descriptions that contributed to the scientific knowledge of the time. His work laid the foundation for further scientific exploration and understanding of these regions.

4 Applications, Mayan and Incan Number Systems

1. Work out the following exercises *using the Mayan system*.

(a) $365 + 365 =$

I NEEDED TO DO IT WITH PENCIL AND PAPER SO I ATTACHED A PHOTO OF MY ANSWER WITHIN THIS ASSIGNMENT

(b) $1024 - 512 =$

2. Work out the following exercises *using the Incan quipu*:

(a) $512 + 256 =$

I NEEDED TO DO IT WITH PENCIL AND PAPER SO I ATTACHED A PHOTO OF MY ANSWER WITHIN THIS ASSIGNMENT

(b) $365 - 67 =$

3. Suppose we are looking for a set of trees tall enough to supply sixteen four-meter beams. Using the Mayan system, create a calculation showing that the total number of beams is sixty-four.

I am unsure :(

4. Suppose you have six terrace plots in the Andean mountains to use to survive. You and your cohort of fellow Incans decide to grow potatoes and quinoa. Quinoa actually do better at higher altitudes than potatoes. So the plan is to use the two lowest terraces for potatoes, and the upper four for quinoa. Each terrace is 30 meters by 5 meters. A potato plant requires a 0.2 meter by 0.2 meter patch, and a quinoa plant requires a 0.3 meter by 0.3 meter patch. How many potato plants and how many quinoa plants can you plant? Store the results in a diagram of quipu knot system.

I'm confused, I struggle with this topic :(

5 Modern Science in Latin America - Gamma Ray Astrophysics

1. What is a gamma-ray?

- A: A charged particle with mass
- B: A neutral particle with mass
- C: A quantum of light
- D: A radio wave

2. What was the purpose of the Milagro experiment?

- A: To observe the direction of incoming gamma-rays
- B: To observe the energy of incoming gamma-rays
- C: To observe the direction and energy of incoming gamma-rays
- D: To observe the charge of incoming gamma-rays

3. What upgrades to the Milagro concept were made that produced the HAWC design?

- A: Using oil instead of water as the detection medium
- B: Increasing the amount of water tanks to improve the sensitivity
- C: Moving the tanks to a higher altitude
- D: Both B and C

4. List some of the discoveries of HAWC and/or Milagro in the field of gamma-ray astrophysics.

1. Identification of the first significant evidence of very high-energy gamma rays from the Crab Nebula, providing insights into the mechanisms of particle acceleration.
2. Contributions to the understanding of the diffuse gamma-ray background, which helps in studying the overall cosmic ray population in the Milky Way.
3. Studies of the energy spectrum of cosmic rays, enhancing knowledge about their origins and the processes that accelerate them.

6 Modern Science in Latin America - Cosmic Ray Physics

1. What is the purpose of the Pierre Auger Observatory?

The purpose of the Pierre Auger Observatory is to study cosmic rays, particularly those of ultra-high energy. It aims to understand the origins and properties of these cosmic rays by detecting and analyzing the extensive air showers they produce when they interact with the Earth's atmosphere. The observatory collects data on the energy, direction, and composition of cosmic rays to gain insights into their sources and the processes that accelerate them.

2. What is the typical energy of a cosmic-ray observed at Auger?

- A: 10^{12} eV
- B: 10^{14} eV
- C: 10^{16} eV
- D: 10^{18} eV