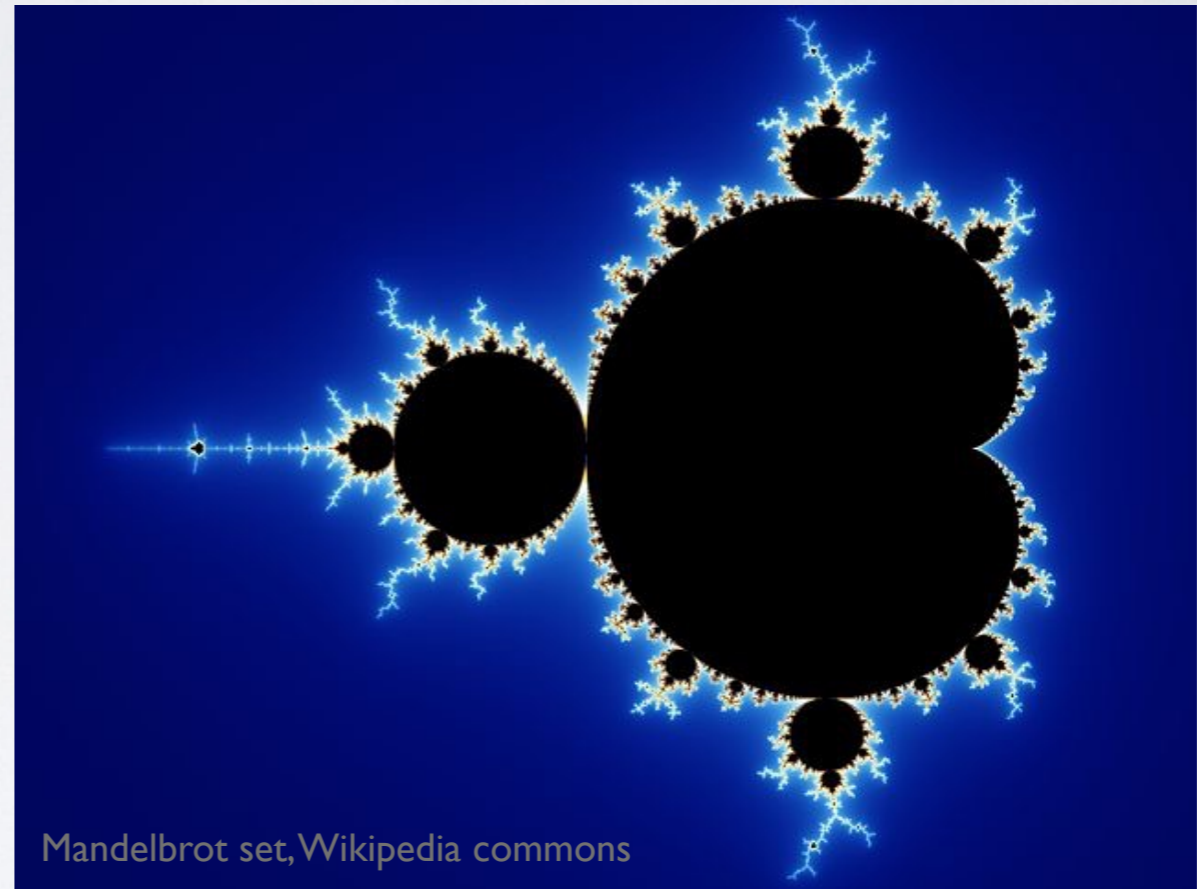


Week 4 - #2

Nonlinear Oscillations and Chaos (II)



Today: Ch 4.4-4.6

Next Class: Ch 4.7-4.8

Ji-hoon Kim (Seoul National University)

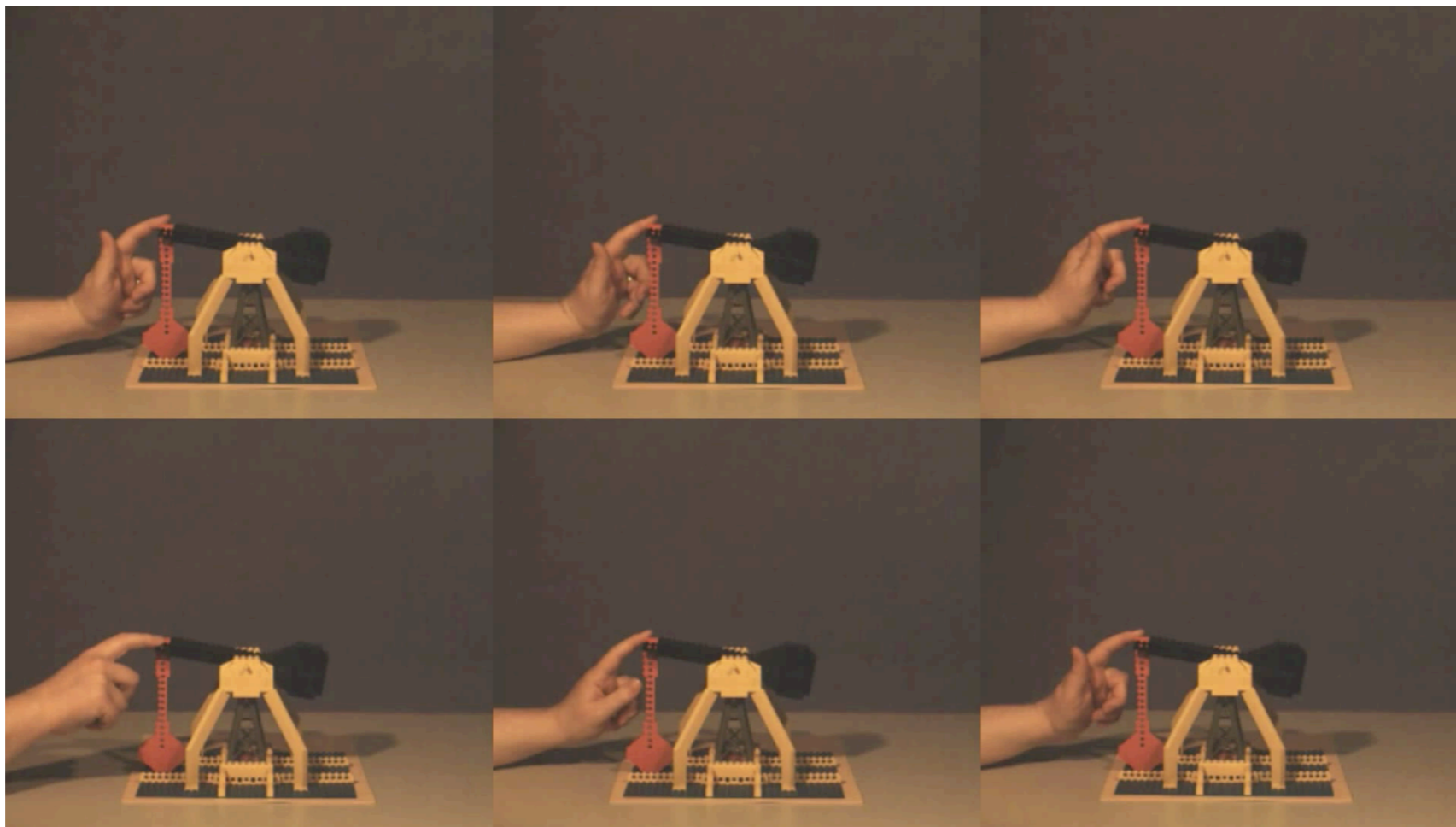
Classical Mechanics I (Spring 2026): Quiz #7

— [open book and open note, **but** no cellphone or laptop, drop it off as you leave the class] —

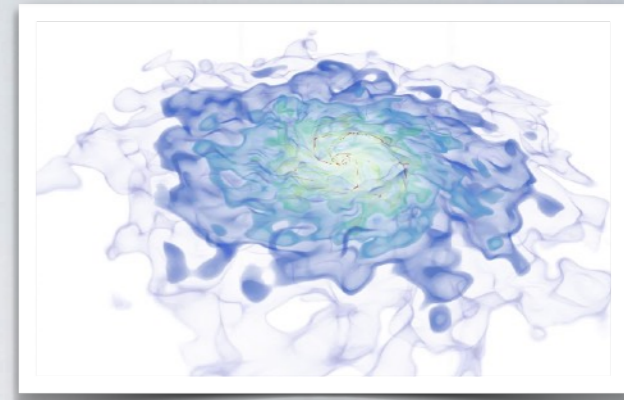
Please write down your name and student ID in the top right corner. (0.0 pt: no paper found with your name / 0.5 pt: paper found with your name and some answers / 1.0 pt: good answers)

1. Thornton & Marion, Problem 4-2.

2. Think of two (or more) examples of chaotic phenomena in the nature, in our society, or in the Universe. Explain why you just called them “chaotic”.



High-speed camera recording of a double pendulum, movie repeats every ~3 min (Wikipedia commons)



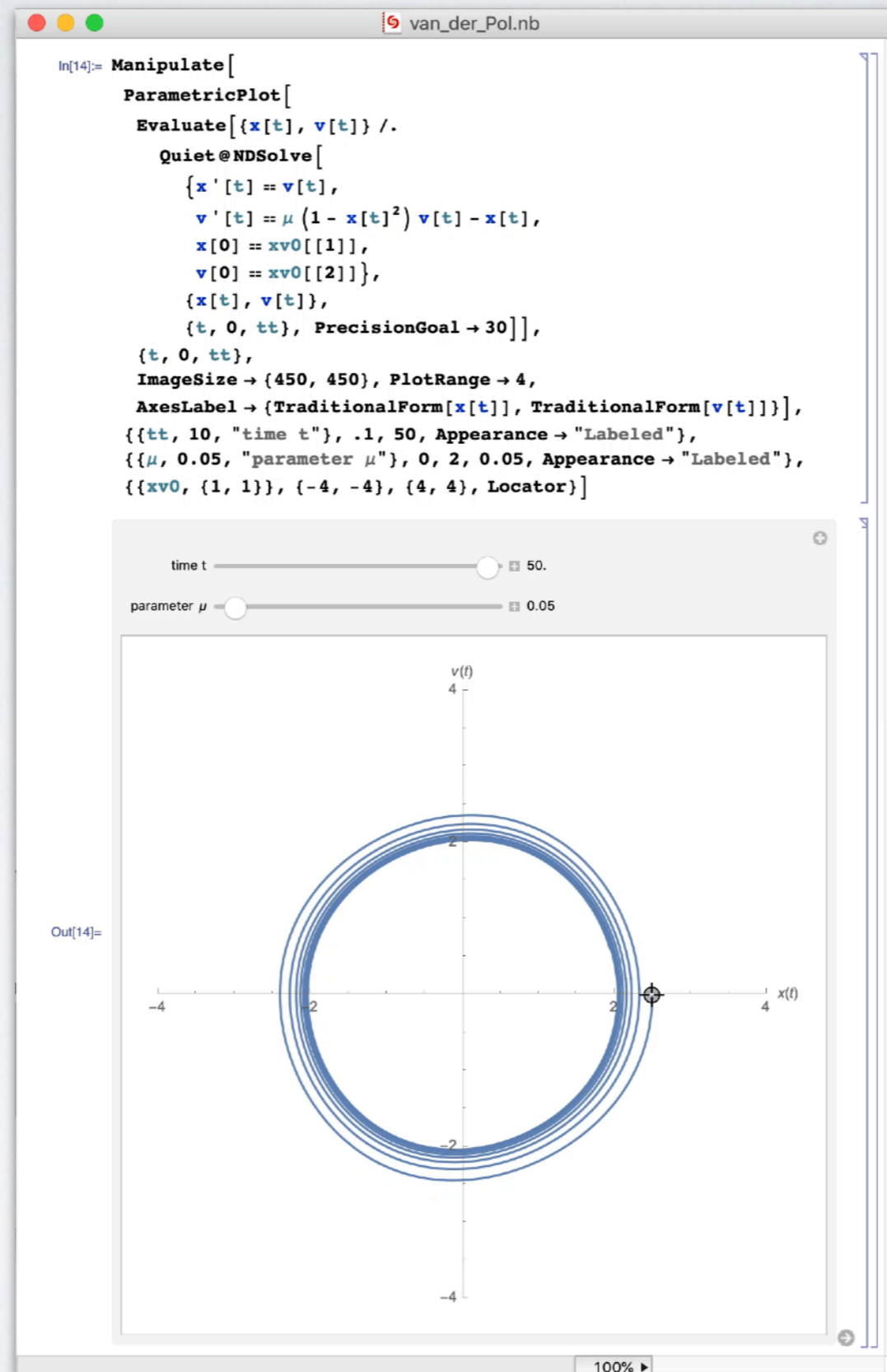
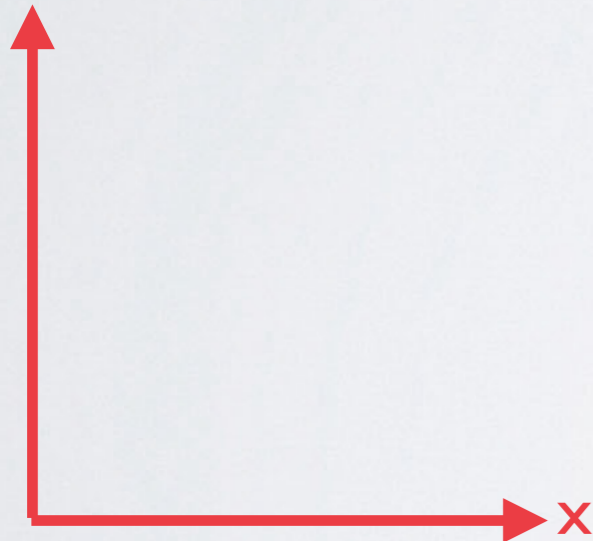
van der Pol Oscillator

van der Pol Oscillator

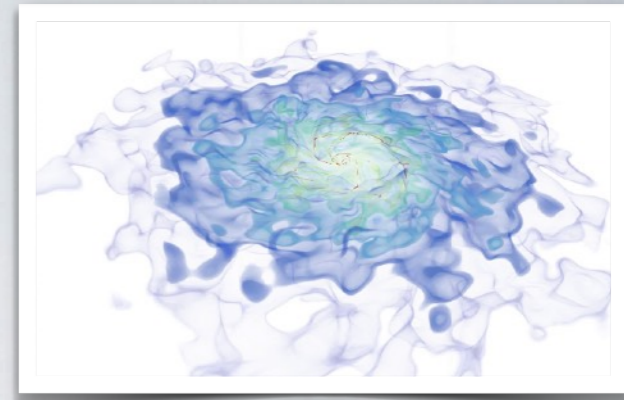
$$\mu = 0.05$$

→ “limit cycle” of $|r| \sim 2$

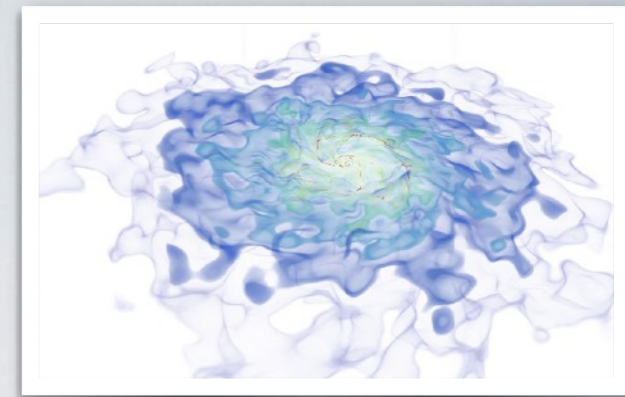
dx/dt



Edited version of
[demonstrations.wolfram.com/
VanDerPolOscillator/](https://demonstrations.wolfram.com/VanDerPolOscillator/)



A Few Logistics Items

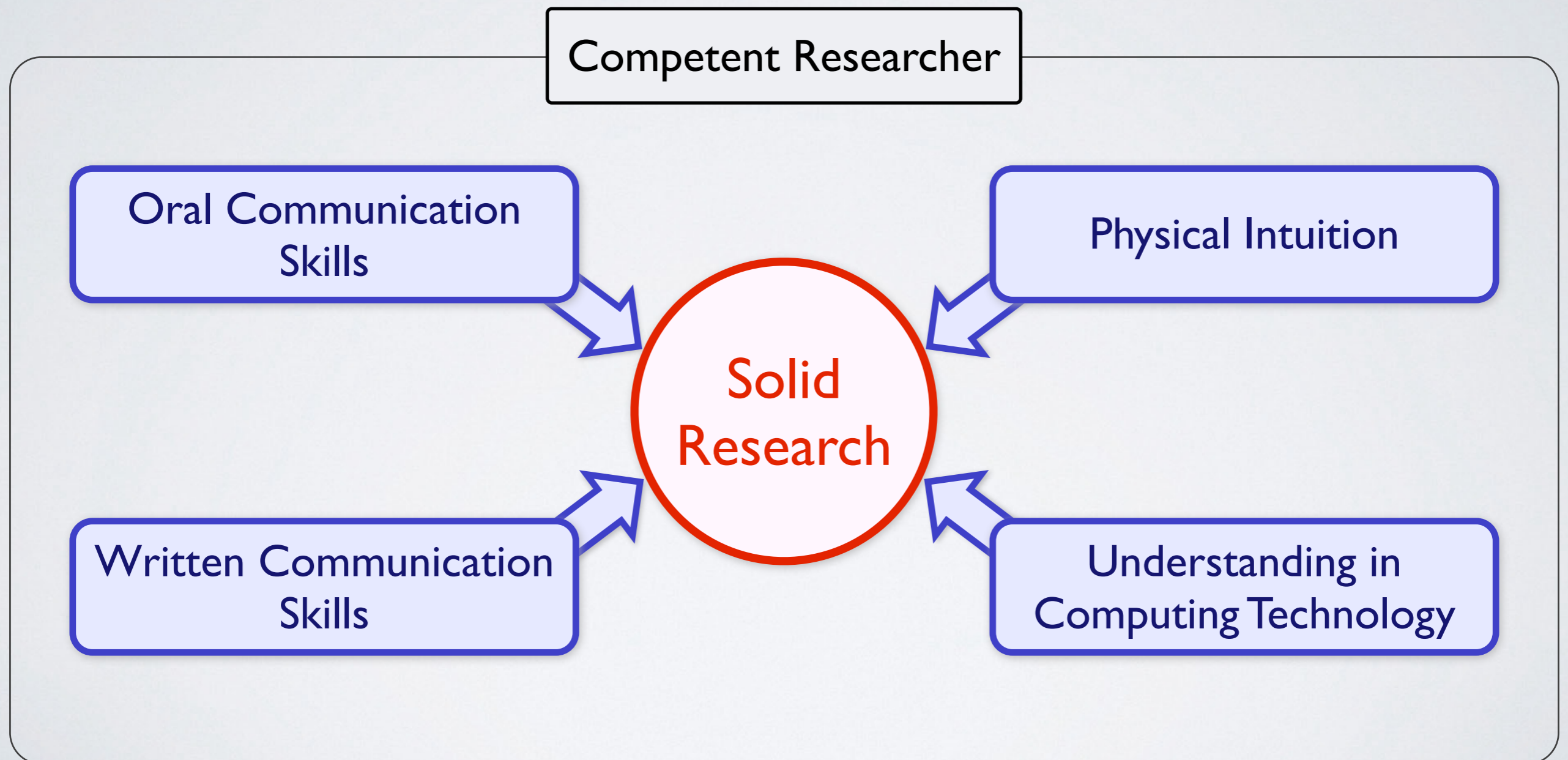


Essential Skillsets For Future Physicists & Astrophysicists

(on top of the strong physics/math background you will build)

Essential Skillsets For (Astro)Physicists

- To become proficient and effective researchers while **relying less on guesswork as you navigate through the academia**



Essential Skillsets For (Astro)Physicists

Competent Researcher

Oral Communication Skills

- How to present long and short talks
- How to answer questions
- How to make an elevator pitch

Written Communication Skills

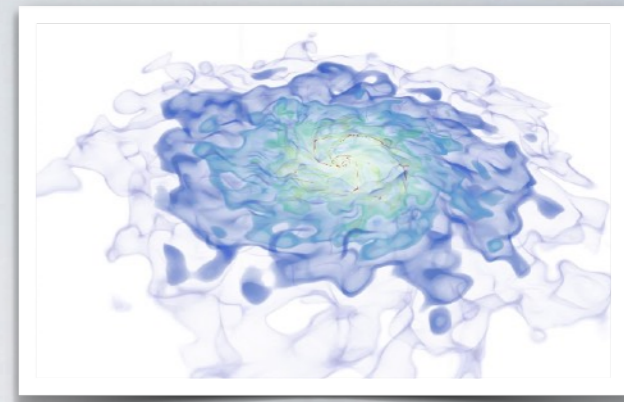
- How to write papers and proceedings
- How to write referee reports
- How to respond to referee reports

Solid
Research

Physical Intuition

Understanding in
Computing Technology





Term Project Paper

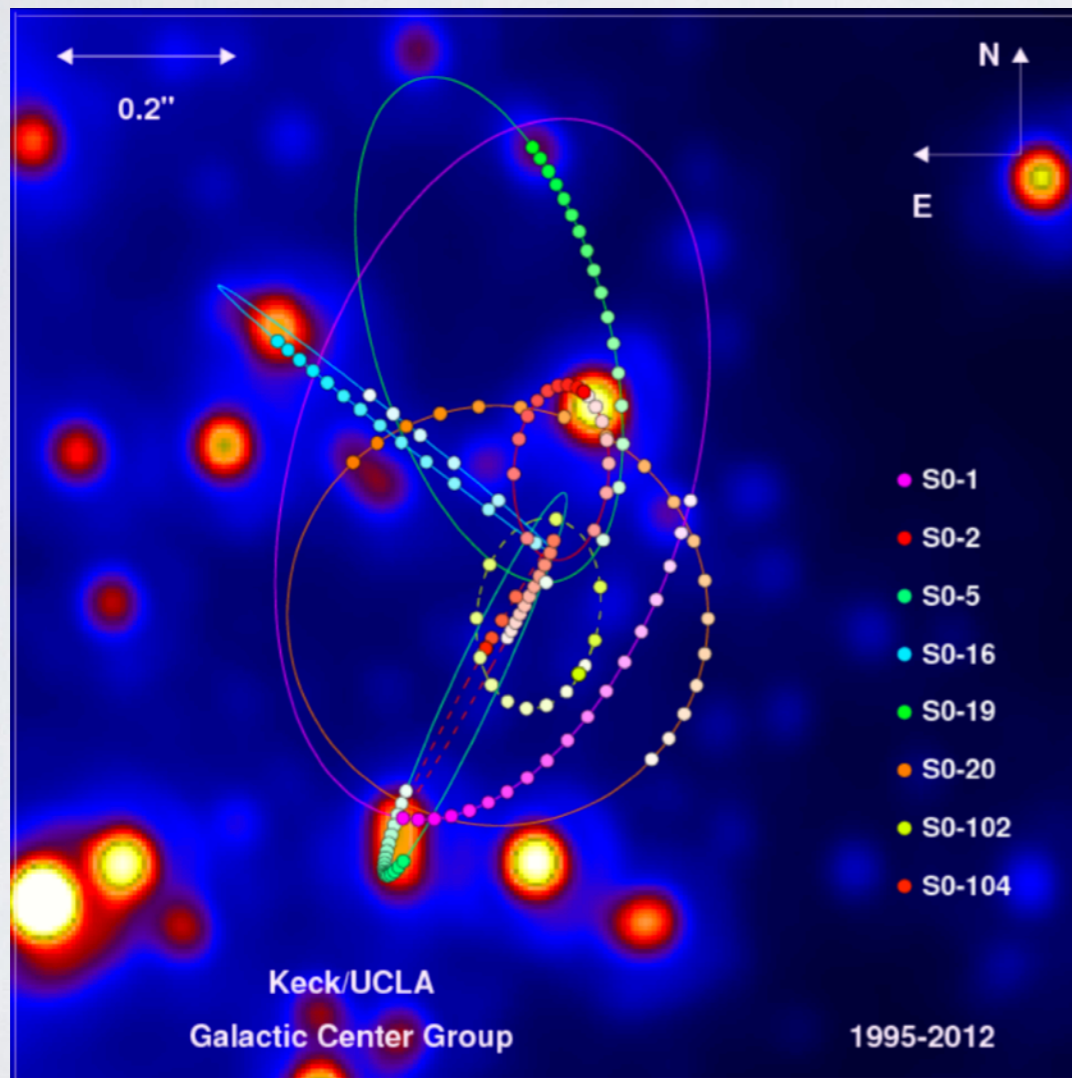
Term Project Paper

- Explore how ideas and methods from classical mechanics play a role in modern research or in everyday phenomena. Must approach the topic creatively and **incorporate your own original insights.**
- Due: Before the class starts on **Jun. 2nd**
(**10 page-limit** including cover/reference; typewritten report okay)

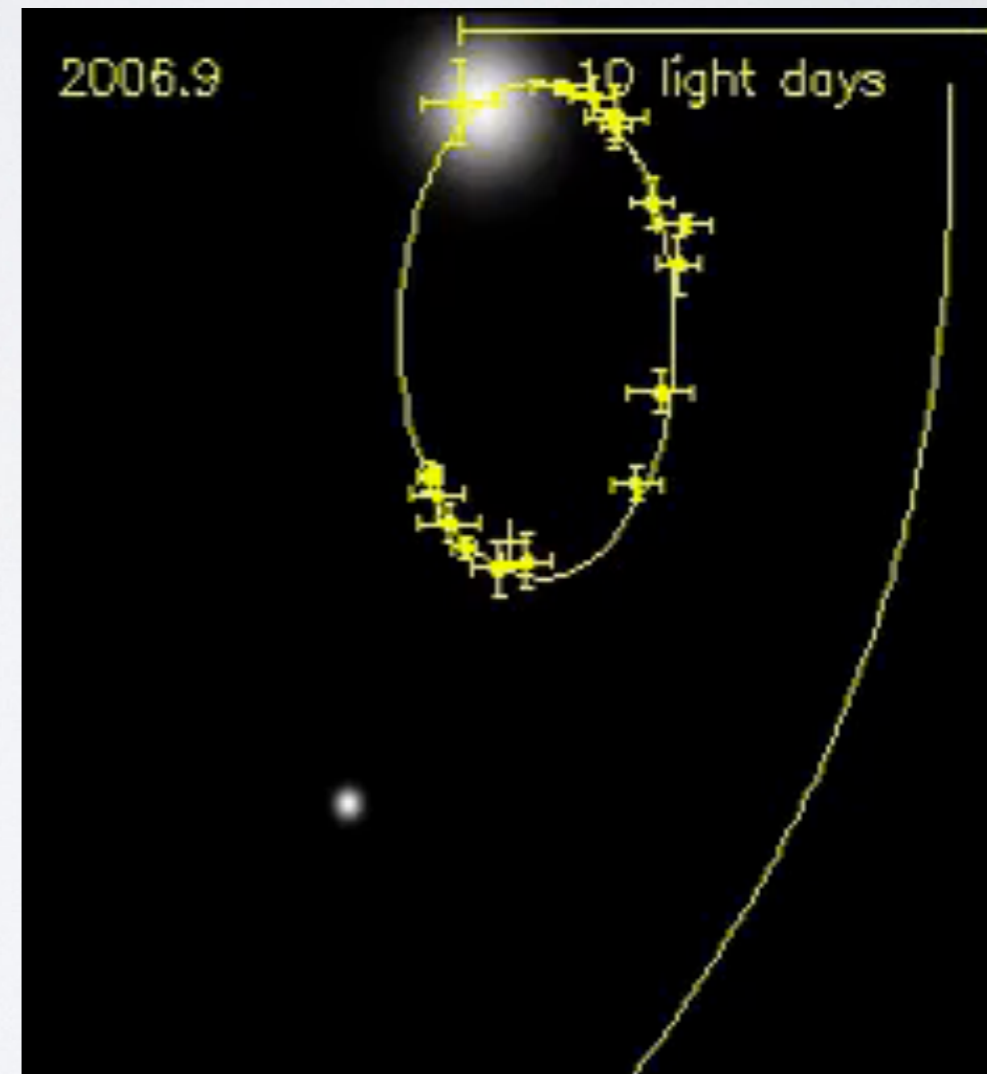


Supermassive BH at Milky Way's Center

- There is enough evidence and a consensus that black holes and **supermassive black holes** (SMBHs) exist.



Data from 1995-2012, Narayan & McClintock (2013)



Schodel et al. (2002)

Forced Oscillation and Resonance

- $\omega_d = \omega$ makes the velocity amplitude greatest. It also makes the displacement amplitude (approximately) greatest.



Tacoma Narrows Bridge collapse (1940), www.youtube.com/watch?v=3mclp9QmCGs

Abstract Art: Drip Painting

- Max Ernst (1891-1976)



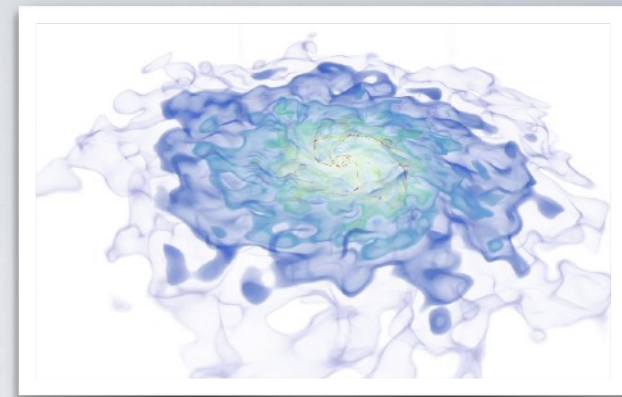
Max Ernst



La Planète Affolée (1942)



Young Man Intrigued by the Flight of a Non-Euclidean Fly (1942, 1947)



Project Ideas

Term Project Paper

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(**10 page-limit** including cover/reference; typewritten report okay)



Damper in Shanghai Tower (1000t, using oil damper + eddy currents), Wiki commons

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- 1: paper found with your name on it
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- 3: reasonable problem & solution
- 4/5: unique, interesting problem & solution
- 6: reserved for those exceptional

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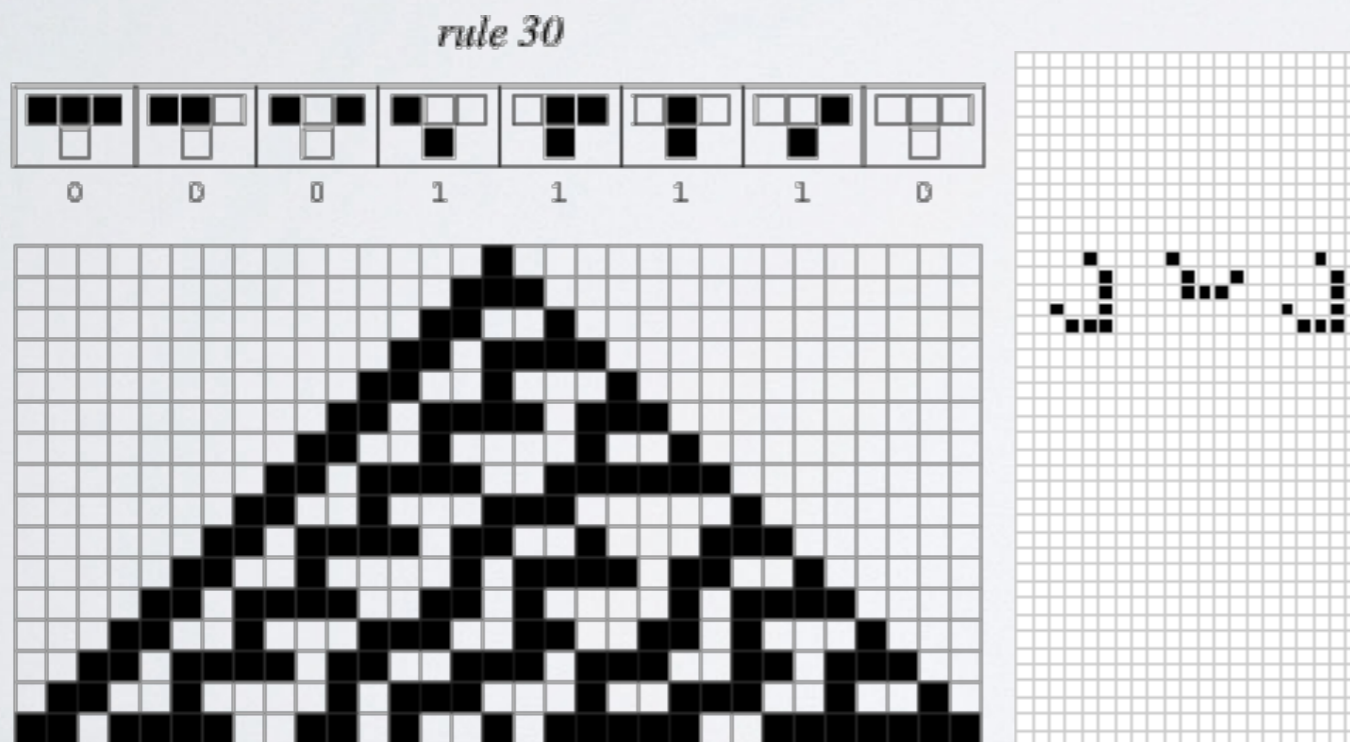
[youtube.com/watch?v=9DaEmvKWSEEA](https://www.youtube.com/watch?v=9DaEmvKWSEEA)

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Cellular Automaton, Wolfram Mathworld

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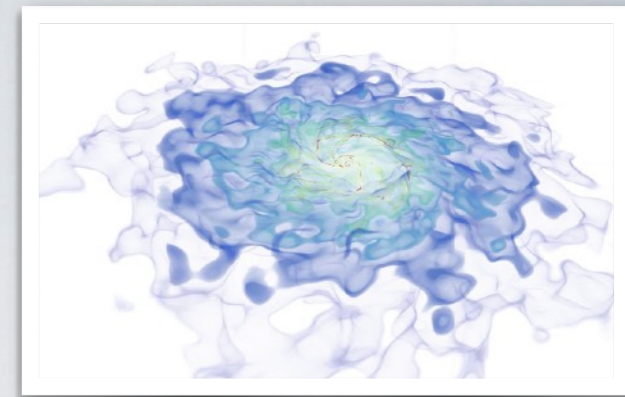
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In the first page, please write down
the total time you spent to prepare
your report!

Student Honor Code

본 과목을 수강하는 학생들은 양심과 책임의식에 기반하며 시험, 과제물 및 보고서 작성 시에 학문의 정직성을 훼손하지 않겠다는 서약을 한 것으로 간주함

“본 과목을 수강하는 학생들은 양심과 책임의식에 기반하여 시험, 과제물 및 보고서 작성시에 학문의 정직성을 훼손하지 않겠다는 서약을 한 것으로 간주함.”

강의 수강 관련

- 시각장애: 교재 제작(디지털교재, 점자교재, 확대교재 등), 대필도우미 허용
- 지체장애: 교재 제작(디지털교재), 대필도우미 및 수업보조 도우미 허용
- 청각장애: 대필 및 문자통역 도우미 활동 허용, 강의 녹취 허용
- 건강장애: 질병 등으로 인한 결석에 대한 출석 인정, 대필도우미 허용
- 학습장애: 대필도우미 허용
- 지적장애/자폐성장애: 대필도우미 및 수업 멘토 허용

과제 및 평가 관련

- 시각장애/지체장애/청각장애/건강장애/학습장애: 과제 제출기한 연장, 과제 제출 및 응답 방식의 조정, 평가 시간 연장, 평가 문항 제시 및 응답 방식의 조정, 별도 고사실 제공
- 지적장애/자폐성장애: 개별화 과제 제출 및 대체 평가 실시

비고

본 강의를 수강하는 장애학생들에게는 이상의 지원 서비스 이외에도 장애학생 개개인의 특성과 요구에 따라, 지도교수 및 장애학생지원센터와의 상담을 통하여 적절한 수준의 지원 서비스를 제공합니다. 장애학생에 대한 지원서비스와 관련하여 문의사항이 있는 학생들은 담당교수 김지후(02-990-1219) 혹은 장애학생지원센터(02-990-9797)로 문의바랍니다.

Student Honor Code

The image is a screenshot of a Science magazine article. At the top, there is a black navigation bar with white text for 'NEWS', 'CAREERS', 'COMMENTARY', 'JOURNALS', and 'COVID-19'. The 'Science' logo is on the right. Below this is a white sub-navigation bar with links for 'News Home', 'All News', 'ScienceInsider', and 'News Features'. The main article area has a dark background with white text. The breadcrumb trail reads 'HOME > NEWS > ALL NEWS > AS SCIENTISTS EXPLORE AI-WRITTEN TEXT, JOURNALS HAMMER OUT POLICIES'. The category is 'NEWS | SCIENTIFIC COMMUNITY'. The title is 'As scientists explore AI-written text, journals hammer out policies'. The subtitle is 'Many ask authors to disclose use of ChatGPT and other generative artificial intelligence'. The byline is '22 FEB 2023 • 1:35 PM • BY JEFFREY BRAINARD'. On the left side, there is a 'SHARE:' section with icons for Twitter, LinkedIn, Facebook, Reddit, WeChat, and Email. The main text of the article is on the right, starting with 'One concern for journal managers is accuracy. If the software hasn't been exposed to enough training data to generate a correct response, it will often fabricate an answer, computer scientists have found. In November, Meta took down the public interface for Galactica, its scientist-specific large language model, just days after it was unveiled—users had identified myriad factual errors in the generated text. And a 2022 preprint study of Sparrow, an information-seeking chatbot developed by a Google subsidiary, found that up to 20% of its responses contained errors. AI text may also be biased toward established scientific ideas and hypotheses contained in the content on which the algorithms were trained. Journal editors also worry about ethics, suggesting authors who use text generators are sometimes presenting the outputs as if they wrote them—a transgression others have dubbed “aigiarism.”' The second paragraph continues: 'Many journals' new policies require that authors disclose use of text-generating tools and ban listing a large language model such as ChatGPT as a co-author, to underscore the human author's responsibility for ensuring the text's accuracy. That is the case for Nature and all Springer Nature journals, the JAMA Network, and groups that advise on best practices in publishing, such as the Committee on Publication Ethics and the World Association of Medical Editors. But at least one publisher has taken a tougher line: The Science family of journals announced a complete ban on generated text last month. The journals may loosen the policy in the future depending on what the scientific community decides is acceptable use of the text generators, Editor-in-Chief Holden Thorp says. “It's a lot easier to loosen our criteria than it is to tighten them.”'

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AI Policy + SNU AI Guideline

<p>*4. 생성형 AI 도구 활용 방침 ※ 필요에 따라 내용 수정 가능</p> <p>교수자별 강의계획서 생성형 AI 도구 활용 방침</p>	<ul style="list-style-type: none"> ■ 본 강의 중 제출하는 모든 과제물(숙제, 퀴즈, 팀 프로젝트, 그 외 교수자가 학기중 지정하는 일체의 과제)은 생성형 AI를 활용하지 않고 작성/제출하며, 교수자와 조교는 이를 전제로 평가합니다. 이는 수강생의 독창적인 문제 해결력과 비판적 사고력 함양을 위한 정책입니다. ■ 다만, 과제 수행에 필요한 자료 검색 및 정리 등 제한적인 목적으로 생성형 AI를 사용할 수 있으며, 그럼에도 불구하고 제출된 과제물은 수강생 자신의 생각을 담은 자신의 언어로 작성되어야 합니다. 또한, 생성형 AI를 과제 수행에 어떤 용도라도 사용한 경우, 사용 도구명, 명령 프롬프트 및 생성 내용 등을 과제물에 명시해야 하며, 이렇게 제출된 과제물에 따르는 모든 책임 (학문의 진실성을 증명할 의무 및 저작권 침해를 방지할 의무 포함)은 본인에게 있음을 인지해야 합니다. 자신의 생각을 반영하여 수정/보완이 되지 않은 AI 산출물을 제출하는 것은 학문의 진실성을 위반한 것으로 평가될 수 있습니다. ■ 그 외에 여기에 명시되지 않은 사항은 "서울대학교 AI 가이드라인"(2025.01)을 준용합니다.
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■ All assignments in this course (including homework, quizzes, term projects, and any other assignments designated by the instructor) must be prepared and submitted without the use of generative AI, and the instructor and TAs will evaluate them under this assumption. This policy is intended to ensure that students develop and demonstrate their own creative problem-solving skills and critical thinking abilities, without reliance on generative AI tools.

■ Generative AI may, however, be used for limited purposes, such as searching for and organizing materials necessary for assignments. Even in such cases, all submitted work must be entirely the student's own and written in the student's own words, reflecting the student's independent thought process. If generative AI is used for any purpose during the completion of an assignment, students must clearly disclose the name of the tool used, the prompts provided, and the generated content. Students must also acknowledge that they bear full responsibility for any consequences arising from such use, including the obligation to uphold academic integrity and to prevent copyright infringement. Submitting AI-generated output without substantial revision or meaningful incorporation of the student's own ideas may be considered a violation of academic integrity.

■ For matters not explicitly addressed here, the "SNU AI Guidelines" (January 2025) shall apply.

Term Project Paper Must Include:

- Your term paper must include:
 1. Your own **originality**
 2. (Optional) Appropriate use of computing or AI, for either (a) a **validated** speed-up, or, (b) data-driven **discovery**

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- 1 Do something original**

Don't just summarize or repeat what others have done.

Your paper should include **your own idea, analysis, or way of thinking about a problem.**

- 2 (Optional) Use computing or AI — but use it properly**

You can use coding or AI tools, but only if they are used in a **meaningful and responsible way.**

There are two good ways to use them:

- **(a) Validated speed-up**

You use computing or AI to do something faster (e.g., calculations, simulations),
but you must check and understand the results yourself.

→ Don't just trust the output—make sure it's correct.

- **(b) Data-driven discovery**

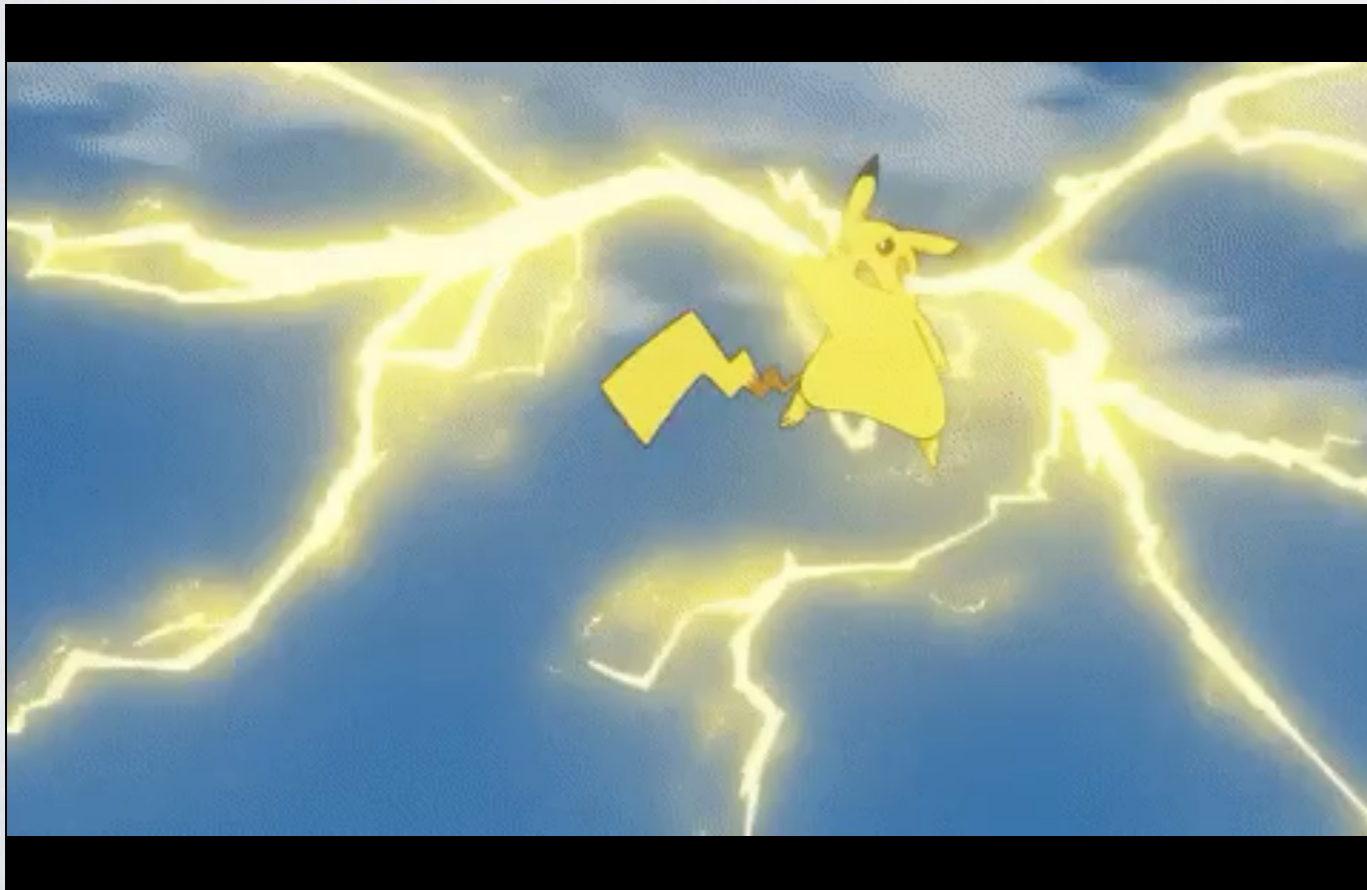
You use data, simulations, or AI to **find patterns, insights, or new results,**
and explain clearly how you got them.

- ⊘ What this is really saying**

- Don't just copy or summarize → **add your own thinking**
- Don't just use AI blindly → **understand and verify what it does**

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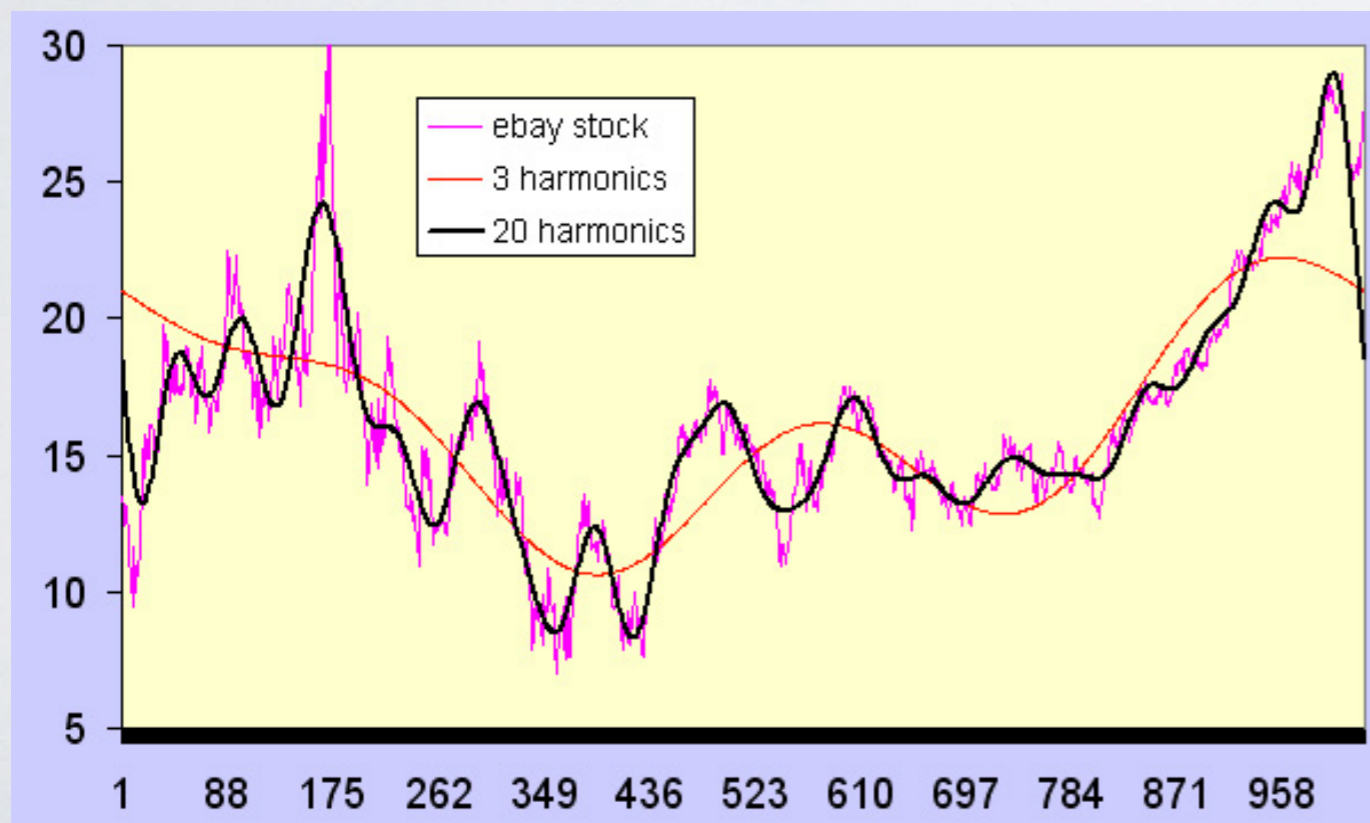
USS Abraham Lincoln, Wikipedia commons

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intelligenttradingtech.blogspot.com

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Term Project: Topic & Progress Check!

- **Post your topic** (+ answer to “What makes your project original?”) and **2-page “progress report” slides** as images **by 23:00 pm, Apr. 26 (Sun)** on a shared Google doc:

<https://docs.google.com/presentation/d/1Mac1w4-myQQ3n05BoOnyfAbkaqpHY120VirbdzBzJP4>

Term Project Progress Check

1. Your Term Paper Topic

- How To Park A Space Colony At Sun-Earth L4 and L5 Point (Lagrange Point)

2. Brief Intro + What Makes Your Project Original?

- 제한 삼체 문제(restricted 3-body problem)와 Lagrange point를 소개하고, 우주 식민지 건설에 대해 지금까지 이루어진 경제성 분석을 검토할 예정. 나아가 L4/L5점에 위치한 우주식민지 주변에서 발생할 수 있는 잠재적 '파멸'시나리오를 상정 후, Wolfram Alpha 또는 MATLAB을 활용해 가능한 회피 기동을 간략히 분석한다. 이렇게 위험 상황을 회피하기 위한 연료 및 자원 소모가 경제적으로 타산이 맞지 않을 수 있다는 가설 (본 연구의 독창적 가설) 을 물리적, 수학적으로 심도있게 검증한다.

Term Project Progress Check

Orbit 1: circles around L5

Orbit 3: circles around L4 and L5

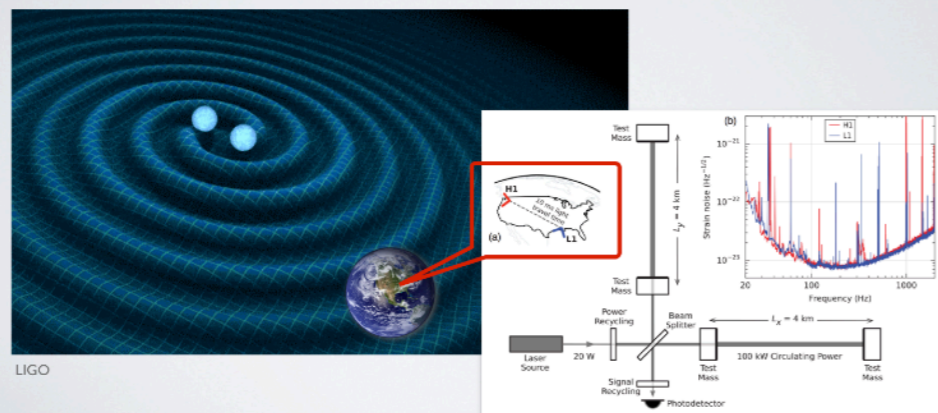
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LIGO Gravitational Wave Signals

- Signals from distant events that distorted the spacetime fabric.
- **A new window to the Universe** opened up in addition to the good old electromagnetic window.

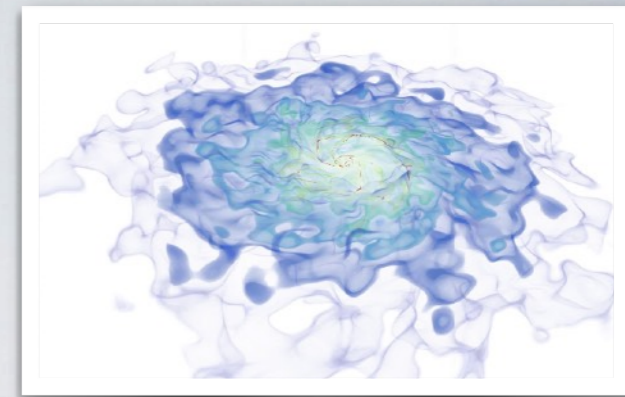


Abbott et al. (2016a)

www.jihoonkim.org

Extra credit guideline

- **Additional +2:** awarded to 2-3 students who were voted the best by your peers, and to 2-3 students who provided the most useful feedback.



**Post the Slides And
Revise Them As Often As You Want**