Física 1 – Ciências Moleculares

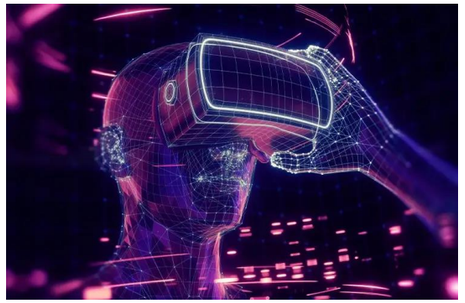
Caetano R. Miranda

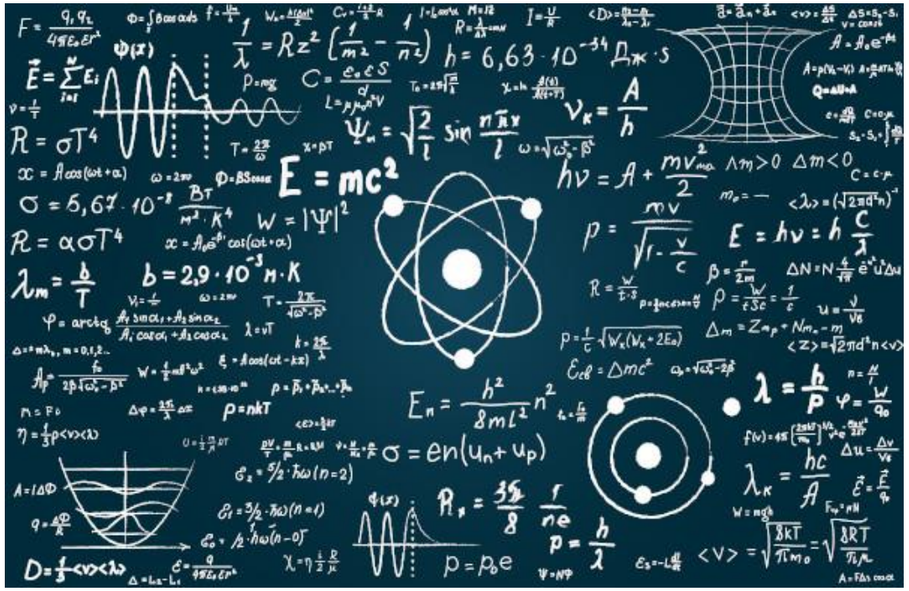
AULA 1 – 21/08/2023

crmiranda@usp.br

Aula Inaugural (21/08/2023)

- O privilégio de ser/estar na Física
- Física e suas interseções
- Dinâmica do curso
- Tour em Física 1





Física 1 ...

Russia

Russia's Luna-25 spacecraft crashes into the moon

https://youtu.be/V6J73gMVtf4

Craft spun into 'unpredictable' orbit before planned touchdown could take place, Russia's state space corporation says

Reuters in Moscow

Sun 20 Aug 2023 13.17 BST

Rocket booster with Luna-25 lunar lander blasts off at Vostochny Cosmodrome on 11 August. Photograph: Roscosmos/Reuters

Russia's first moon mission in 47 years failed when its Luna-25 spacecraft spun out of control and crashed into the moon after a problem preparing for pre-landing orbit, underscoring the post-Soviet decline of a once mighty space programme.

Info e Equipe

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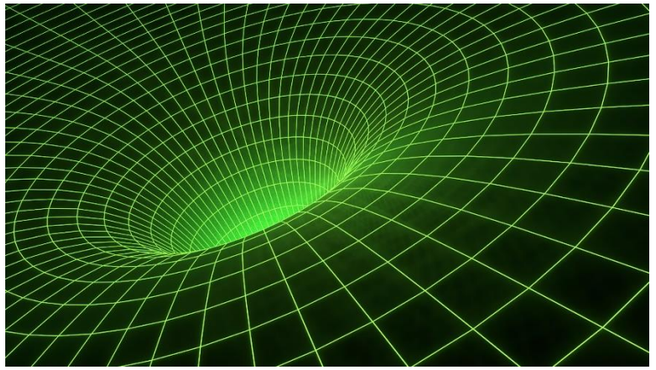
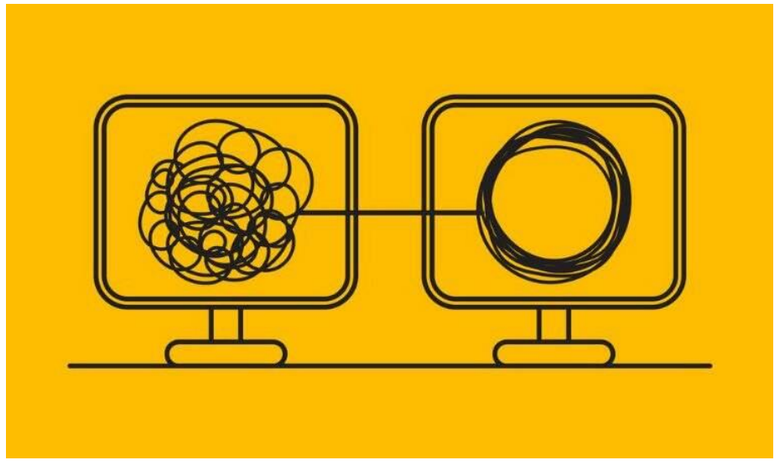
Dúvidas use o HOTLINE: crmiranda@usp.br
Assunto: CCM2023

WhatsApp: https://chat.whatsapp.com/



Victor van Driel
vicvandriel@usp.br



Espaço-Tempo:
14:00 – 15:45
Sala CCM

Entregas: Moodle

https://edisciplinas.usp.br/course/view.php?id=114663

Todas as dúvidas serão comentadas no inicio das aulas.
Sessões a combinar com o monitor

PAIXÃO PELA FÍSICA

O que é Física para você ?

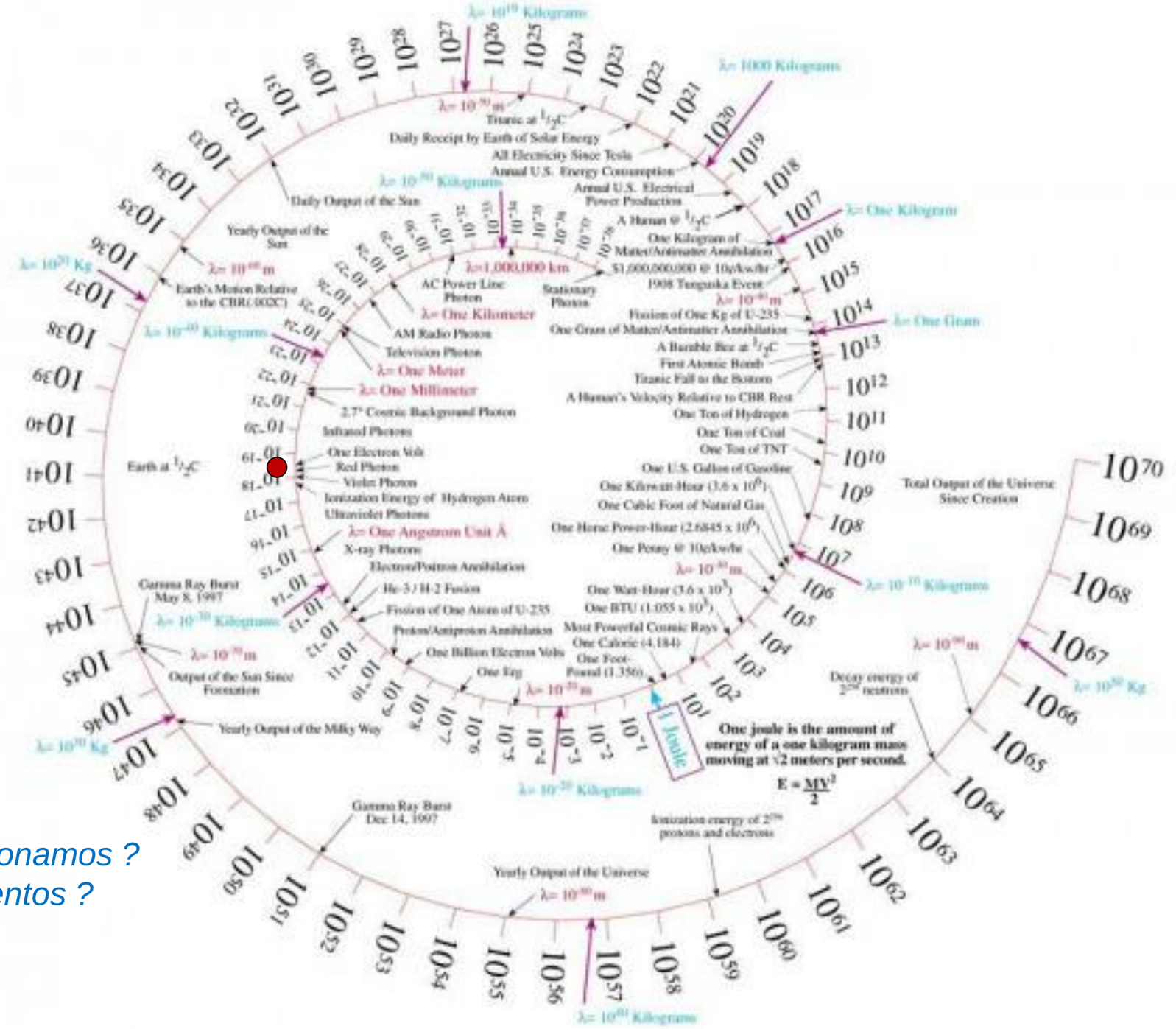
Indique três palavras que você identifica com a Física:

https://www.menti.com/alnik1x7awmn

Turma 33 – 21/08/2023

Escalas de energia

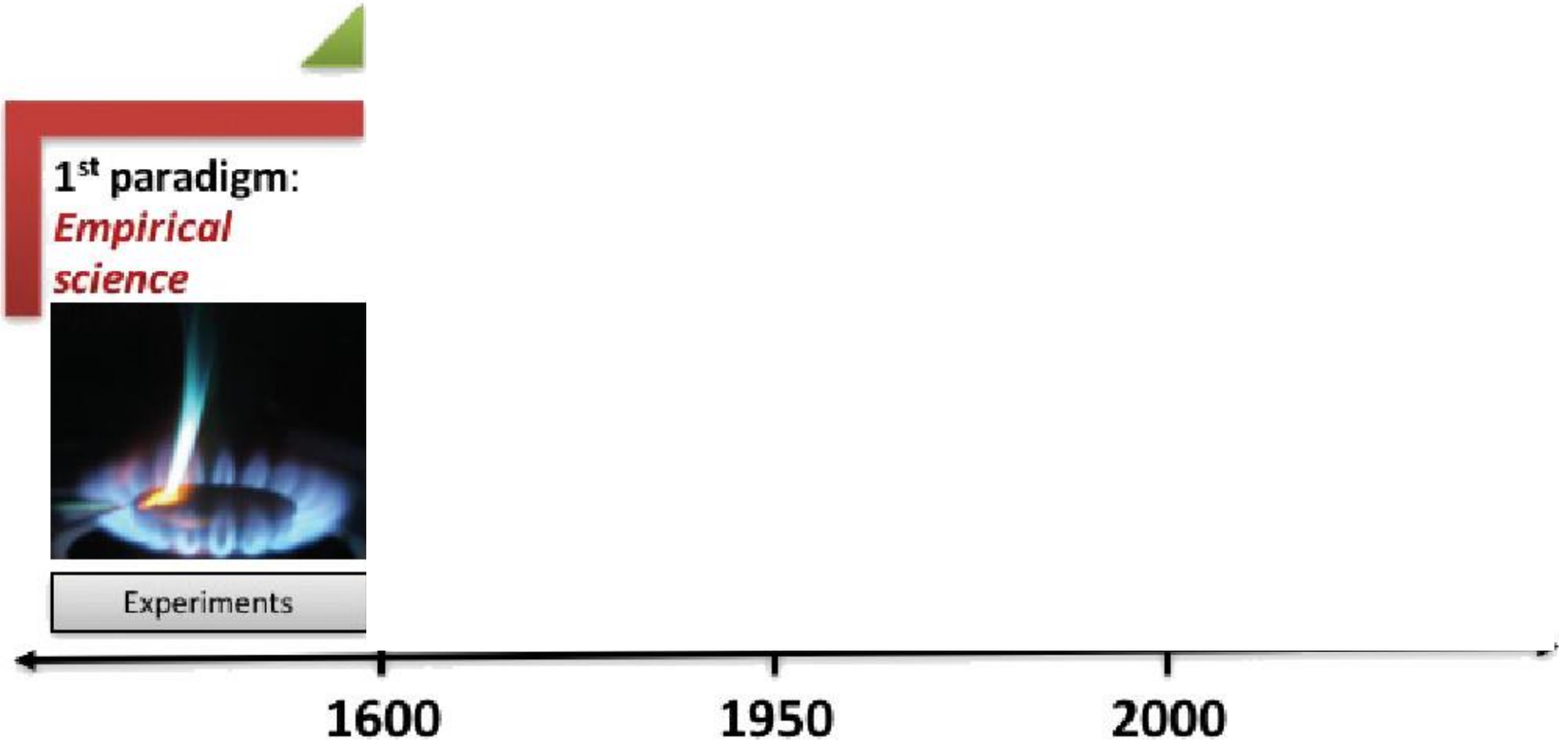
O que medimos (vemos e sentimos) ?
Como classificamos, modelamos ou correlacionamos ?
O que construimos a partir desses conhecimentos ?



Do sonho de Laplace …

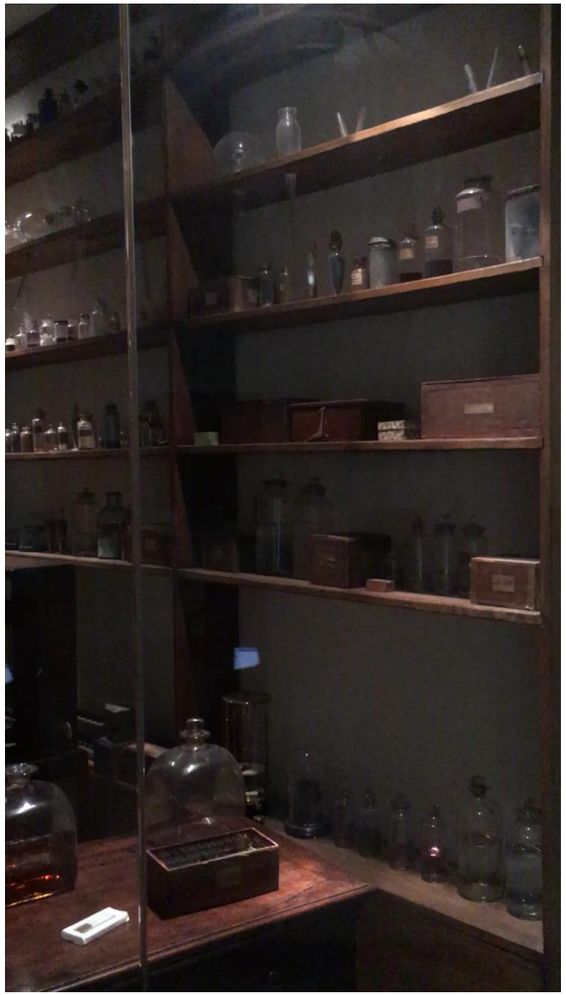
Uma *inteligência* que pode, a qualquer momento, compreender *todas as forças* pelas quais a natureza é animada e as *respectivas posições* dos seres que o compõem, e além disso, se essa inteligência fosse abrangente o suficiente para submeter esses *dados à análise*, abrangeria nessa fórmula ambos os movimentos dos *maiores corpos* no universo e aqueles dos *átomos* mais leves: para ele nada seria ser incerto, e o futuro, assim como o passado, seria presente aos seus olhos. A mente humana nos oferece, *na perfeição que deu à astronomia*, um esboço tênue dessa inteligência.

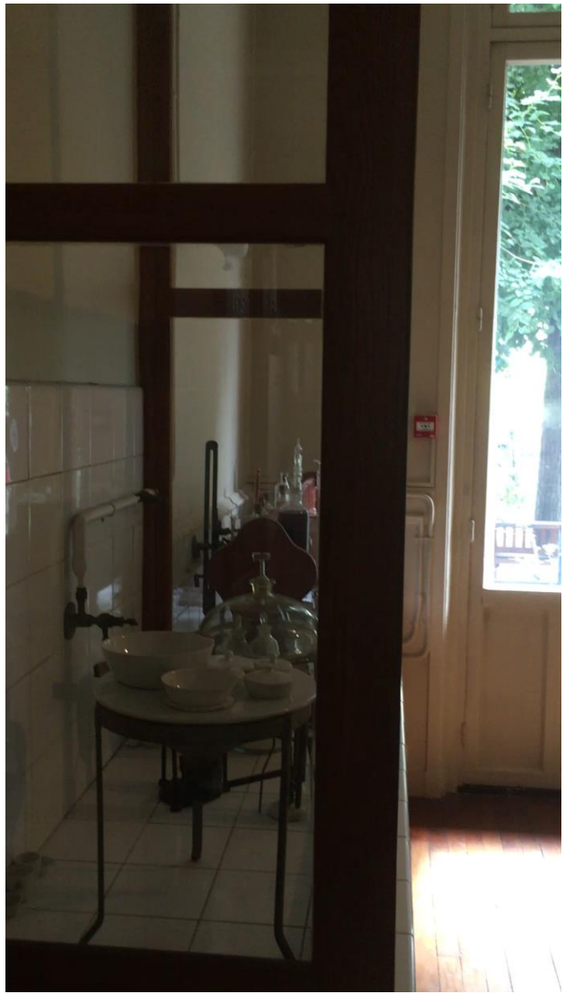
P. S. de Laplace. Oeuvres Completes de Laplace. Thiorie Analytique des ProbabiliUs, volume VII. Gauthier-Villars, Paris, France, third edition, 1820.



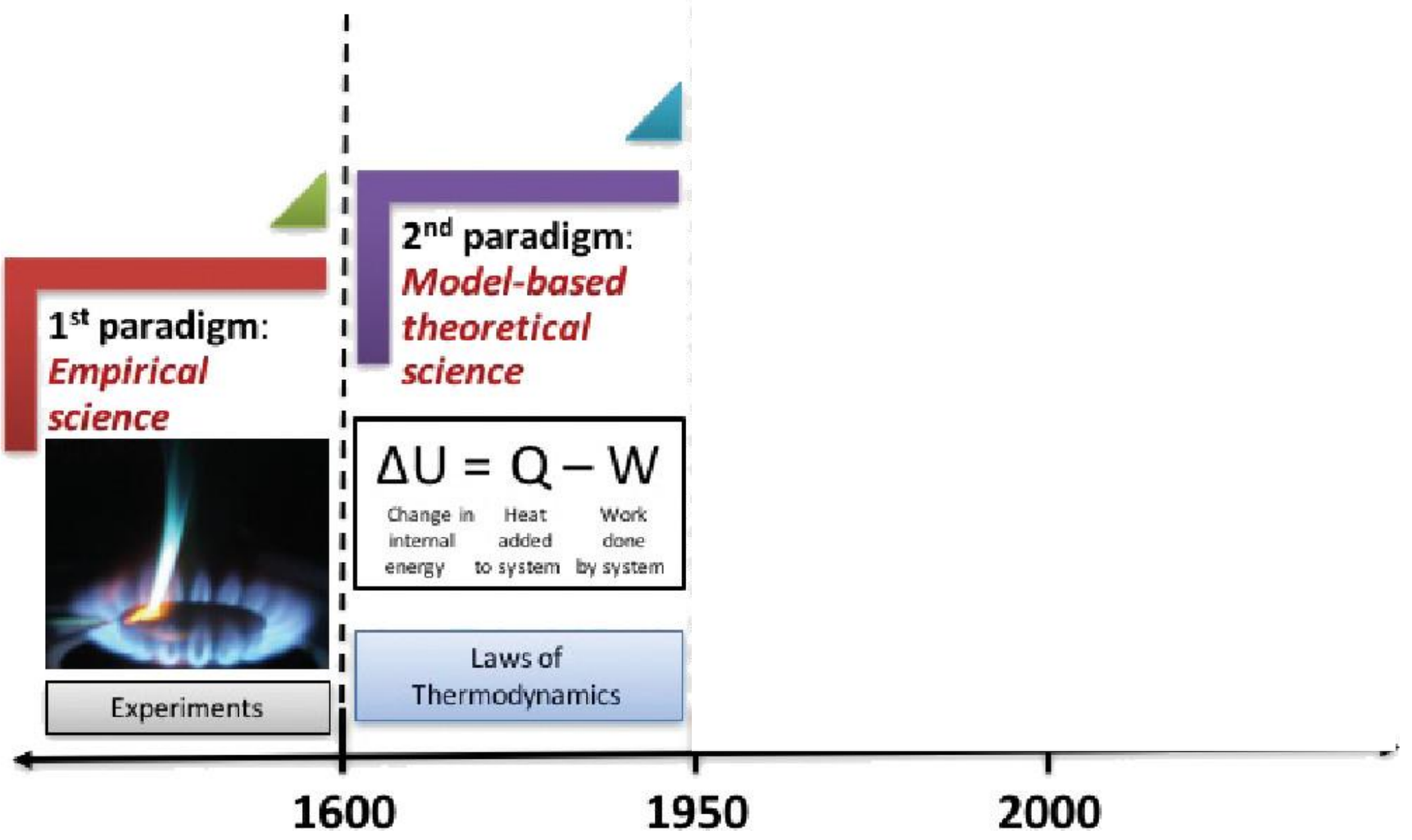
Published in: Ankit Agrawal; Alok Choudhary; *APL Materials* **4,** 053208 (2016)
DOI: 10.1063/1.4946894

Espaços





Visita ao Sirius – Agendar



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A arte de resolver problemas através da Física

Carl Wieman is a professor of physics and of education at Stanford University in California.

Carl Wieman

All scientists and engineers solve research problems by calling on relevant knowledge to make a series of common, critical decisions.

THE NATURE OF PHYSICS PROBLEM-SOLVING

Below are 29 sets of questions that students and physicists need to ask themselves during the research process. The answers at each step allow them to make the 29 decisions needed to solve a physics problem. (Adapted from reference 3.)

A. SELECTION AND PLANNING

1. What is important in the field? Where is the field heading? Are there advances in the field that open new possibilities?

2. Are there opportunities that fit the physicist's expertise? Are there gaps in the field that need solving or opportunities to challenge the status quo and question assumptions in the field? Given experts' capabilities, are there opportunities particularly accessible to them?

3. What are the goals, design criteria, or requirements of the problem solution? What is the scope of the problem? What will be the criteria on which the solution is evaluated?

4. What are the important underlying features or concepts that apply? Which available information is relevant to solving the problem and why? To better identify the important information, create a suitable representation of core ideas.

5. Which predictive frameworks should be used? Decide on the appropriate level of mechanism and structure that the framework needs to be most useful for the problem at hand.

6. How can the problem be narrowed? Formulate specific questions and hypotheses to make the problem more tractable.

7. What are related problems or work that have been seen before? What aspects of their problem-solving process and solutions might be useful?

8. What are some potential solutions? (This decision is based on experience and the results of decisions 3 and 4.)

9. Is the problem plausibly solvable? Is the solution worth pursuing given the difficulties, constraints, risks, and uncertainties?

Decisions 10–15 establish the specifics needed to solve the problem.

10. What approximations or simplifications are appropriate?

11. How can the research problem be decomposed into subproblems? Subproblems are independently solvable pieces with their own subgoals.

12. Which areas of a problem are particularly difficult or uncertain in the solving process? What are acceptable levels of uncertainty with which to proceed at various stages?

13. What information is needed to solve the problem? What approach will be sufficient to test and distinguish between potential solutions?

14. Which among the many competing considerations should be prioritized? Considerations could include the following: What are the most important or most difficult? What are the time, materials, and cost constraints?

15. How can necessary information be obtained? Options include designing and conducting experiments, making observations, talking to experts, consulting the literature, performing calculations, building models, and using simulations. Plans also involve setting milestones and metrics for evaluating progress and considering possible alternative outcomes and paths that may arise during the problem-solving process.

B. ANALYSIS AND CONCLUSIONS

16. Which calculations and data analysis should be done? How should they be carried out?

17. What is the best way to represent and organize available information to provide clarity and insights?

18. Is information valid, reliable, and believable? Is the interpretation unbiased?

19. How does information compare with predictions? As new information is collected, how does it compare with expected results based on the predictive framework?

20. If a result is different from expected, how should one follow up? Does a potential anomaly fit within the acceptable range of predictive frameworks, given their limitations and underlying assumptions and approximations?

21. What are appropriate, justifiable conclusions based on the data?

22. What is the best solution from the candidate solutions? To narrow down the list, decide which of those solutions are consistent with all available information, and which can be rejected. Determine what refinements need to be made to the candidate solutions. For this decision, which should be made repeatedly throughout the problem-solving process, the candidate list need not be narrowed down to a single solution.

23. Are previous decisions about simplifications and predictive frameworks still appropriate in light of new information? Does the chosen predictive framework need to be modified?

24. Is the physicist's relevant knowledge and the current information they have sufficient? Is more information needed, and if so, what is it? Does some information need to be verified?

25. How well is the problem-solving approach working? Does it need to be modified? A physicist should reflect on their strategy by evaluating progress toward the solution and possibly revising their goals.

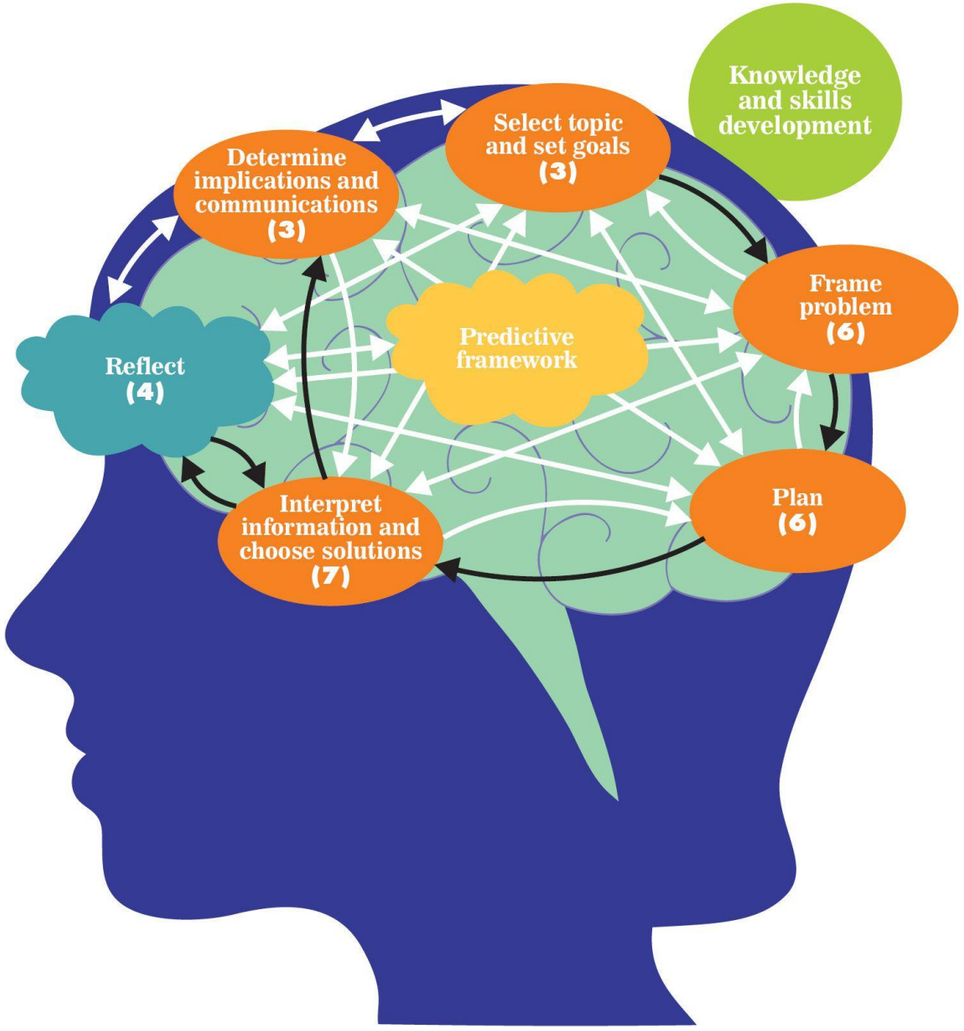
26. How good is the chosen solution? After selecting one from the candidate solutions and reflecting on it, does it make sense and pass discipline-specific tests for solutions to the problem? How might it fail?

Decisions 27–29 are about the significance of the work and how to communicate the results.

27. What are the broader implications of the results? Over what range of contexts does the solution apply? What outstanding problems in the field might it solve? What novel predictions can it enable? How and why might the solution be seen as interesting to a broader community?

28. Who is the audience for the work? What are the audience's important characteristics?

29. What is the best way to present the work to have it understood and to have its correctness and importance appreciated? How can a compelling story be made of the work?



A arte de resolver problemas através da Física

The primary characteristic of a successful physicist is being a good problem solver. Real physics problems are those pursued in research. Solving such problems involves a far more complex set of mental processes than are needed for even the most difficult textbook problem. Unlike real problems, textbook problems provide all the information needed and have a single well-defined path to a solution.

“Hard” and “Soft” habilidades

In addition to the decisions, which were our focus, the experts volunteered common areas of general skills they saw as important elements of expertise in their fields.

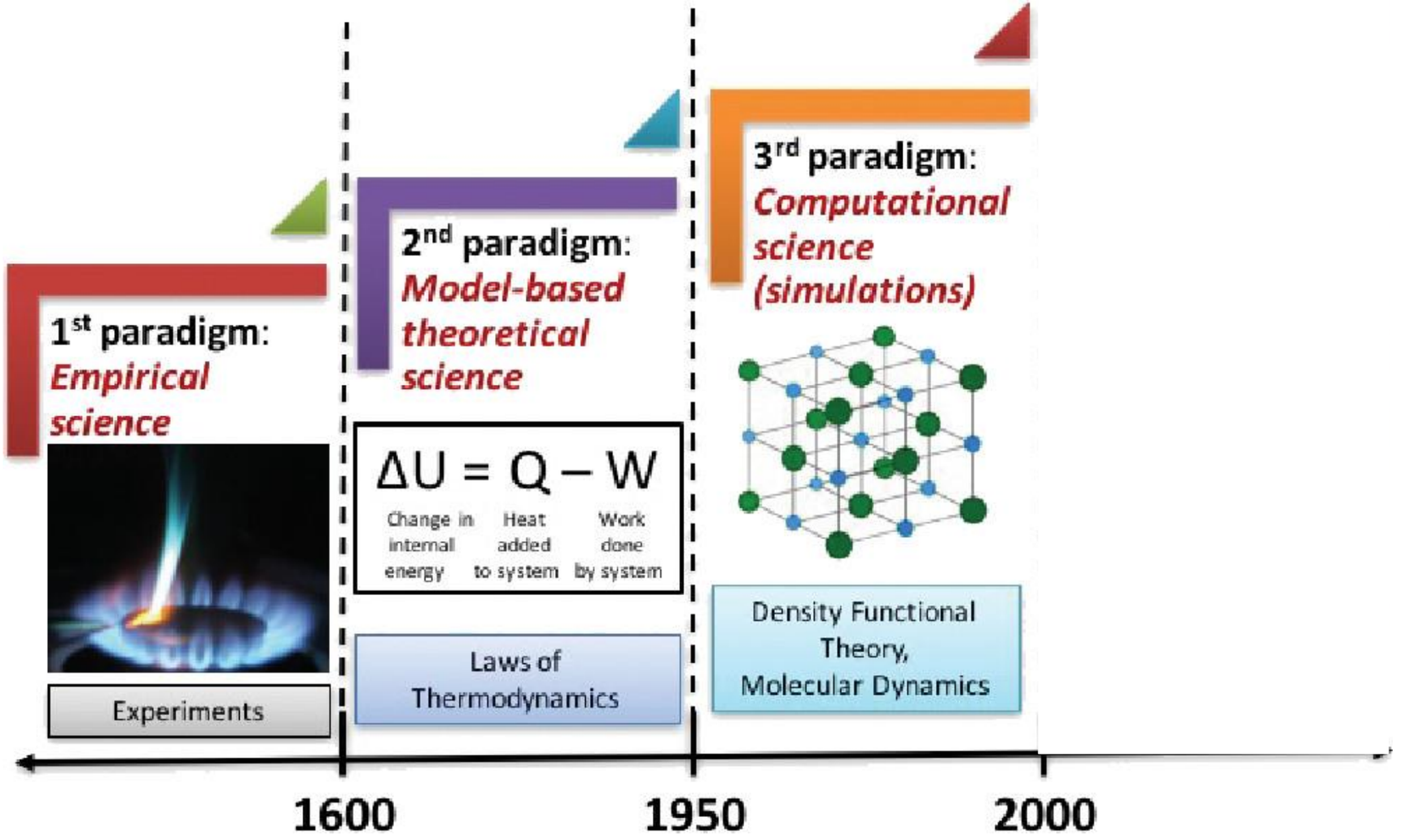
Stay up to date in the field by learning relevant new knowledge, ideas, and technology from literature, conferences, and colleagues.

Develop intuition and experience to improve problem-solving.

Enhance interpersonal and teamwork skills—for example, how to navigate collaborations, manage a team, and strengthen communication—particularly as they apply in the context of the different problem-solving processes.

Improve one’s efficiency by practicing time management, including learning to complete certain common tasks efficiently and accurately.

Cultivate an attitude, or motivation, which includes persevering in the task despite obstacles, dealing with stress, and having confidence in decisions.



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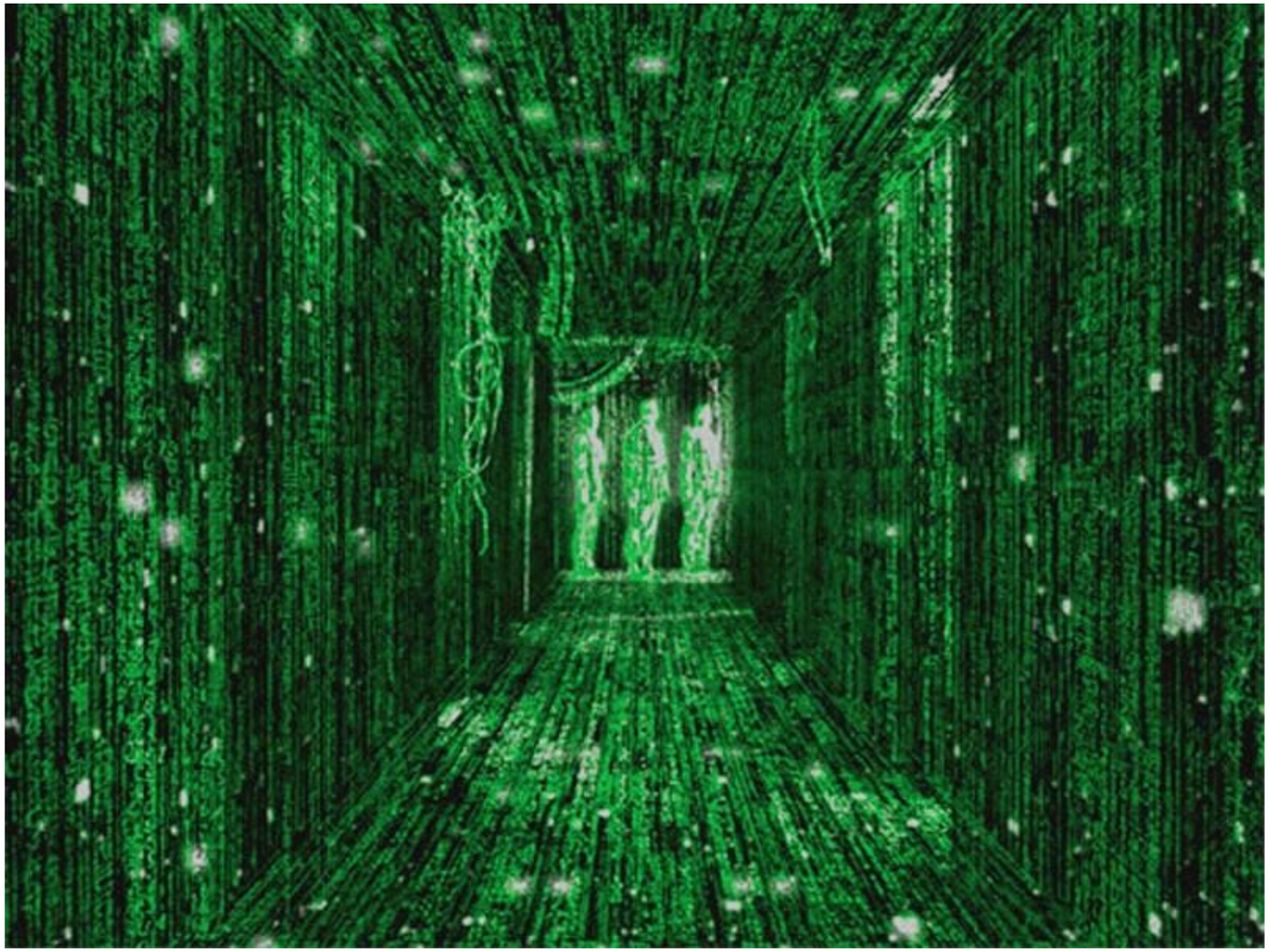
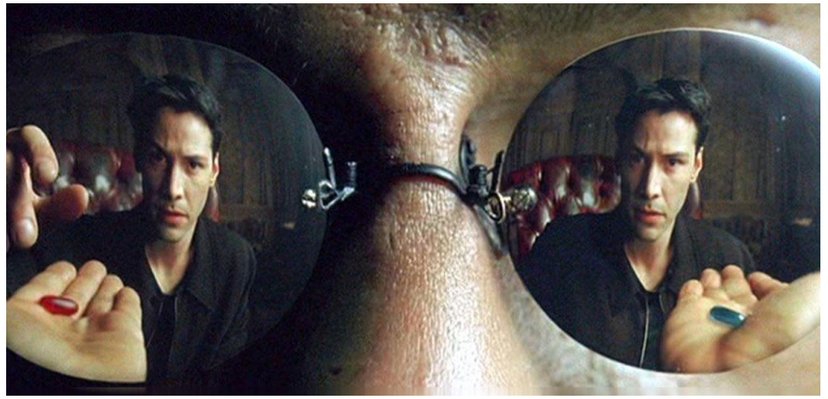
Simulacros e Simulação



Baseado em Jean Baudrillard

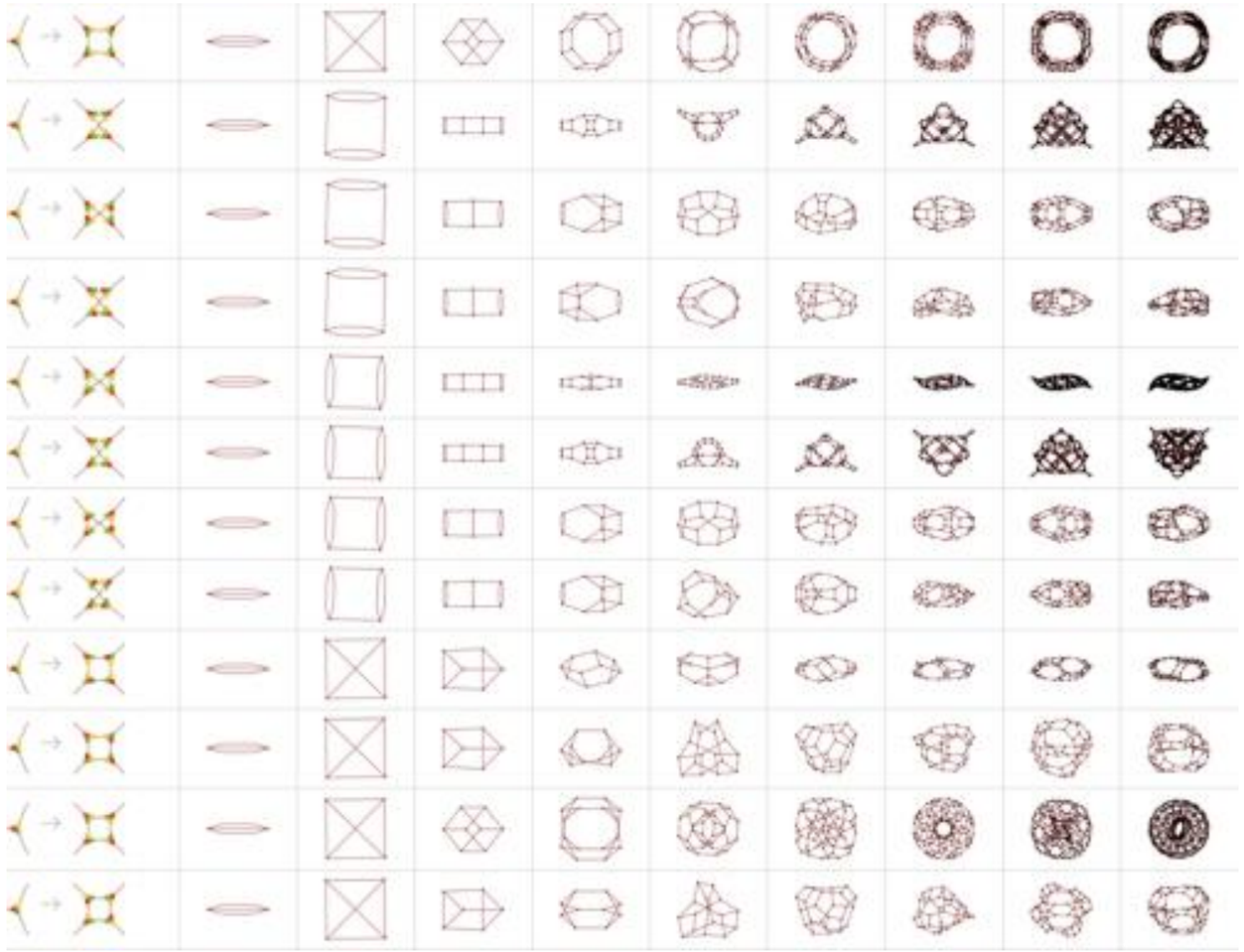
Extraído do filme – Matrix (1999)

Simulacros e Simulação



Simulação tornou-se uma forma de experimentação em um universo de teorias – Gary Flake (The computational Beauty of Nature – MIT press)

Seria possível simular o universo em um computador ?

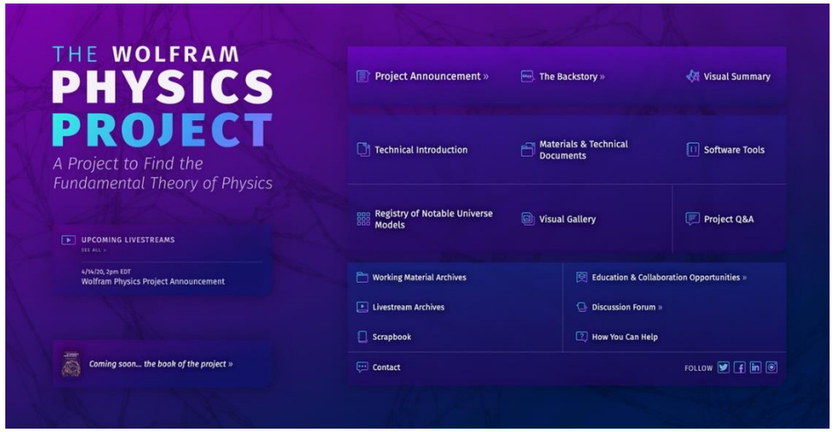


Stephen Wolfram desenvolveu o Mathematica e Wolfram Alpha. Agora ele quer simular o “universo”.

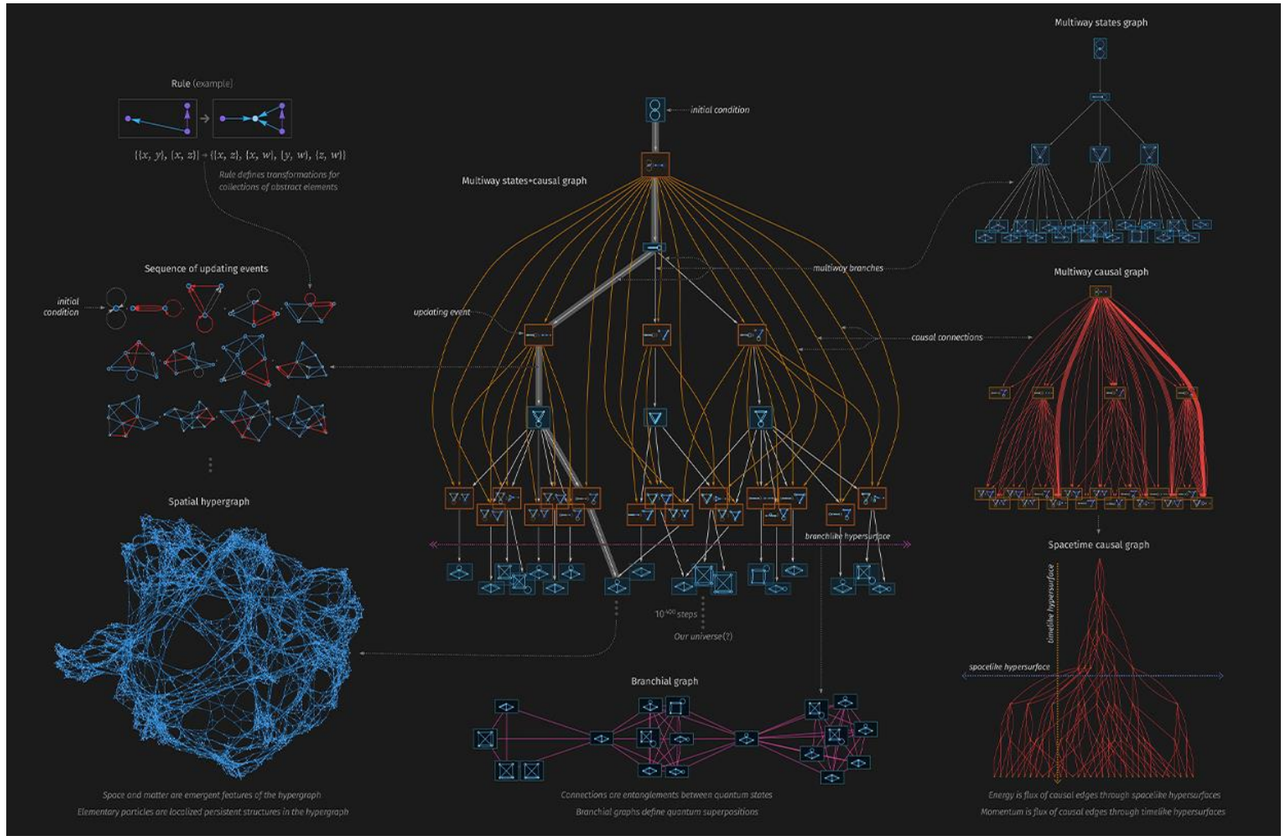
The Wolfram Physics Project
Abril 2020

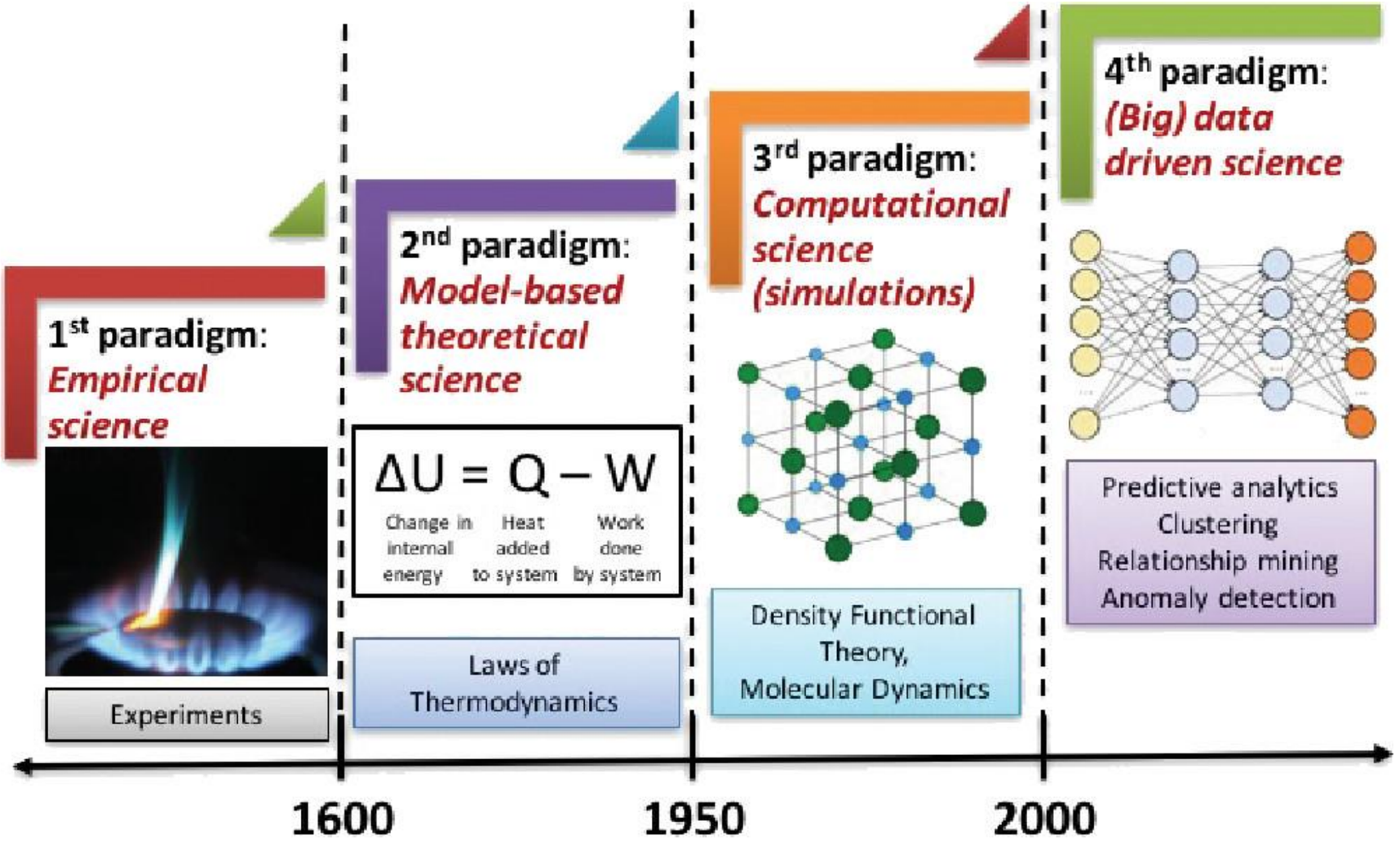
Wolfram

Até que ponto a física pode nos aproximar de uma compreensão verdadeiramente fundamental do mundo?



https://www.wolframphysics.org/





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O PAPEL SOCIAL DA FÍSICA

Em colaboração com: Dindara S. Galvão, Guilherme S. Santos, Gustavo Chagas, Raíssa S. Borges, Renata Biazzi, Suryendrani Baptistuta, Teresa D. Lanna

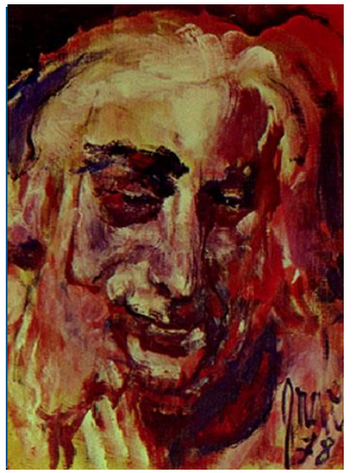
O privilégio de ser um(a) Físico(a)

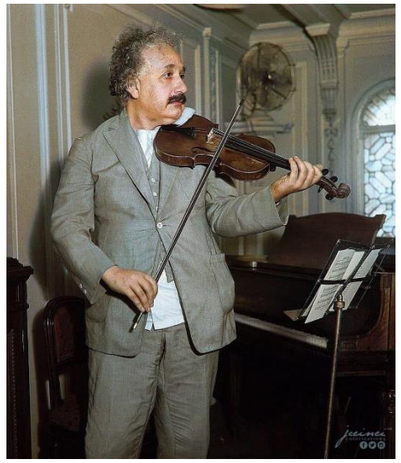
The Privilege of Being a Physicist

“Por causa da posição central da ciência em nossa civilização, os físicos deveriam estar profundamente preocupados com o envolvimento da ciência nos assuntos culturais e políticos globais.”

Victor F. Weisskopf

- Desafios globais
- Permeia todos os meios de produção
- Além das fronteiras e Percepção Pública
- Ensino (experimentações)

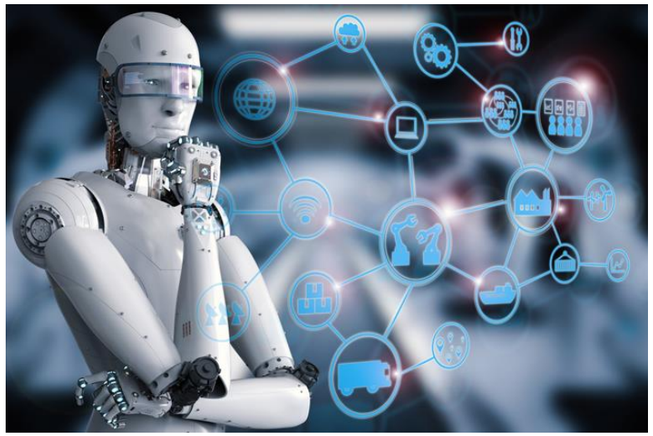


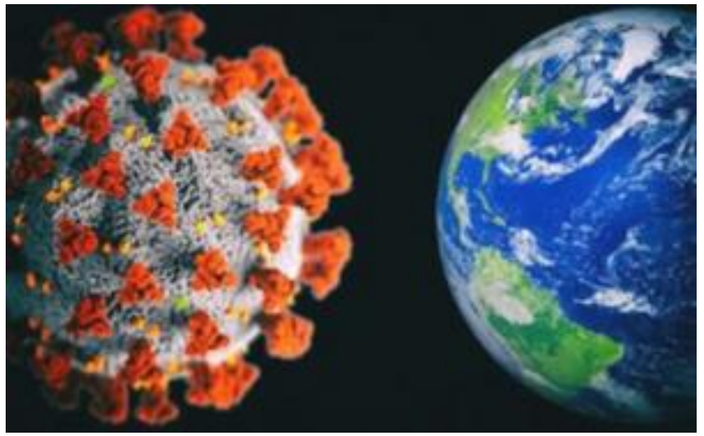


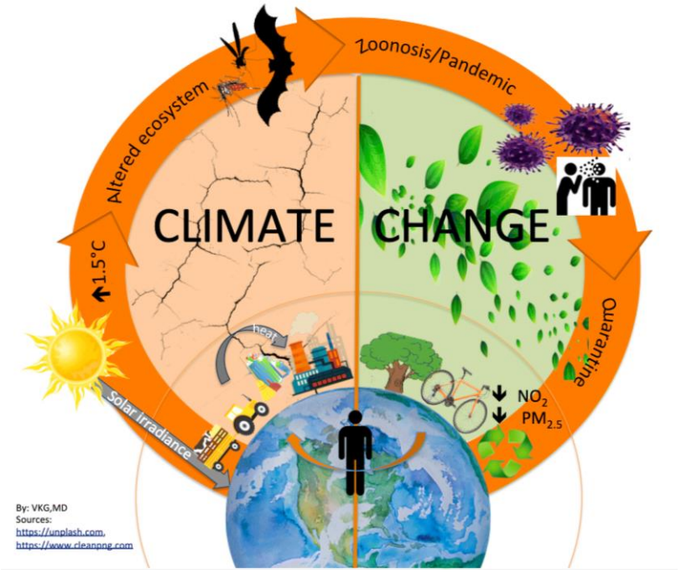
Physics Today **56**, 2, 48 (2003); https://doi.org/10.1063/1.1564349

Principais problemas da humanidade nos próximos 50 anos (… em 2003)

1. ENERGIA
2. ÁGUA LIMPA
3. ALIMENTOS
4. MEIO AMBIENTE
5. POBREZA
6. TERRORISMO E GUERRA
7. DOENÇA
8. EDUCAÇÃO
9. DEMOCRACIA
10. POPULAÇÃO







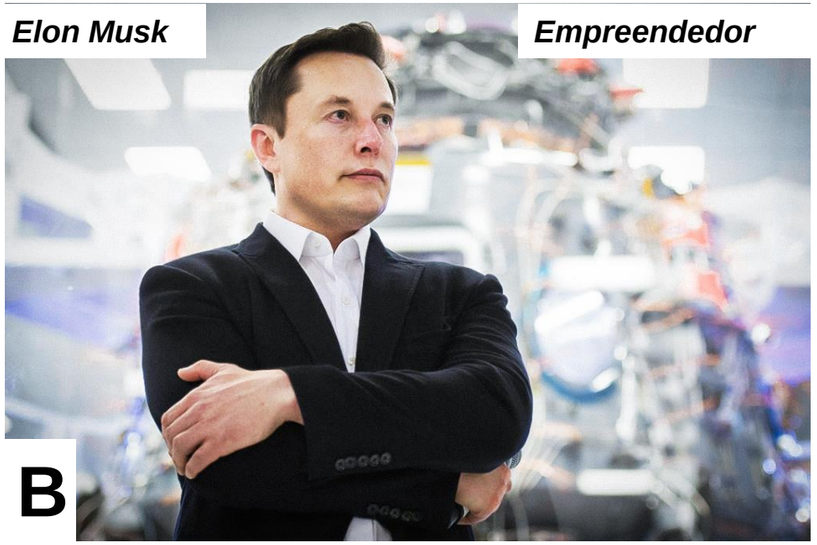
"We have to learn to think in a new way." (Russel-Einstein Manifesto, July 9, 1955, London)

Objetivos de desenvolvimento sustentável (Agenda das Nações Unidas em 2015 para 2030)

Os Objetivos de Desenvolvimento Sustentável são uma chamada universal à ação para erradicar a pobreza, proteger o planeta e melhorar a vida e as perspectivas de todos, em todos os lugares.

Da atualidade. Quem mais se alinha com suas aspirações ?

Elon Musk

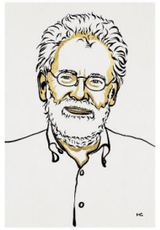


Empreendedor

B

Ill. Niklas Elmehed © Nobel Prize Outreach
Alain Aspect

Ill. Niklas Elmehed © Nobel Prize Outreach
John F. Clauser



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Anton Zeilinger

The Nobel Prize in Physics 2020

Ill. Niklas Elmehed. © Nobel Media.
Roger Penrose

Ill. Niklas Elmehed. © Nobel Media.
Reinhard Genzel

Ill. Niklas Elmehed. © Nobel Media.
Andrea Ghez

Brian May – The Queen

Pop-star

C

Angela Merkel

D

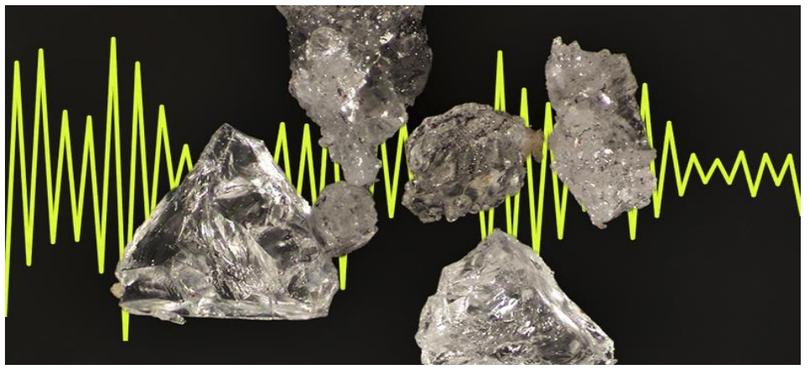
Líder do mundo livre

Kim Jong-un

Líder supremo

E

Simulação Aplicada em Materiais: Propriedades Atomísticas

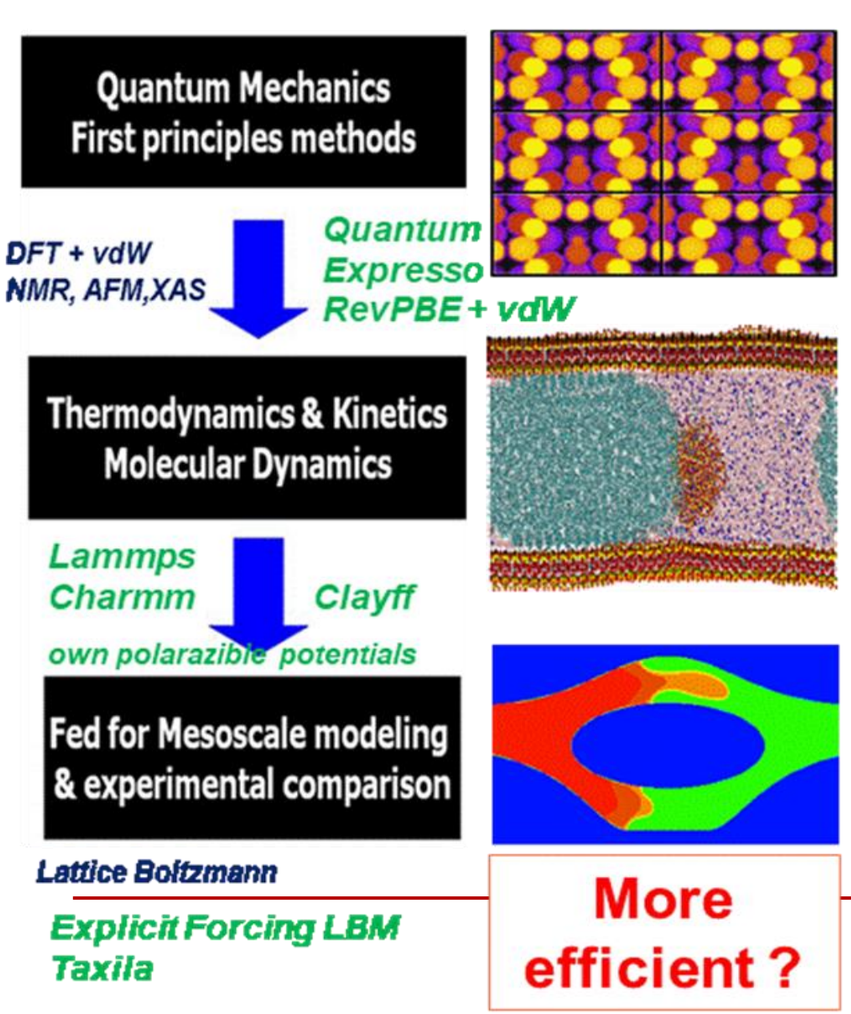


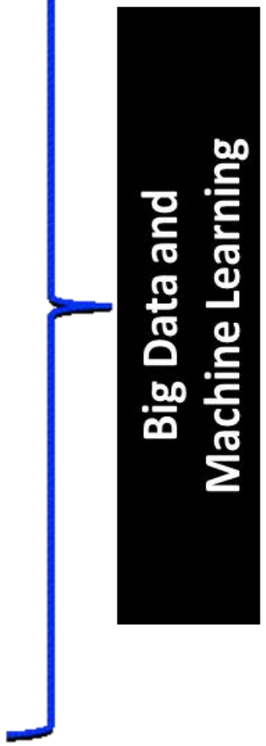
TV USP - 01/10/2018

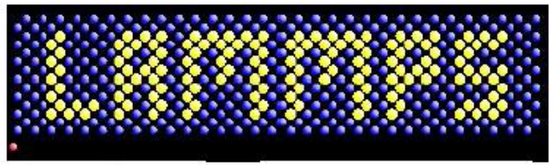
Cientistas utilizam realidade virtual para criar novos materiais

Simulações moleculares e Jogos

Para fornecer uma experiência imersiva em nanoescala:
Desenvolver e integrar simulações moleculares e ferramentas de jogos para VR







NOMAD
NOVEL MATERIALS DISCOVERY

unity
mol

MARIIAS: Transformando Realidades Através de Tecnologias Imersivas na Educação

Plataforma para recursos de aprendizado inclusivos e interativos

META: Promover, incentivar e apoiar estudantes de **baixa renda** e, principalmente, **mulheres e meninas** em C & T.

Experiências perceptivas e tecnologias emergentes usando:

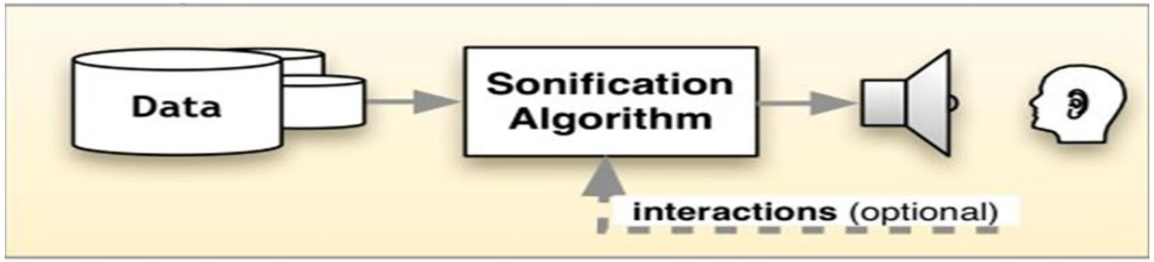
1) Realidade virtual e sonificação

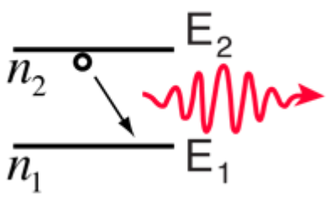
2) Experiências imersivas e inclusivas de baixo custo

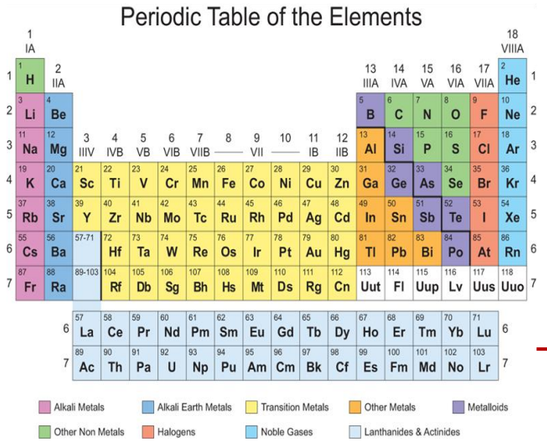
*(Metodologias de Aprendizagem e Recursos de Interação Inclusivos em Ambientes de Simulação)

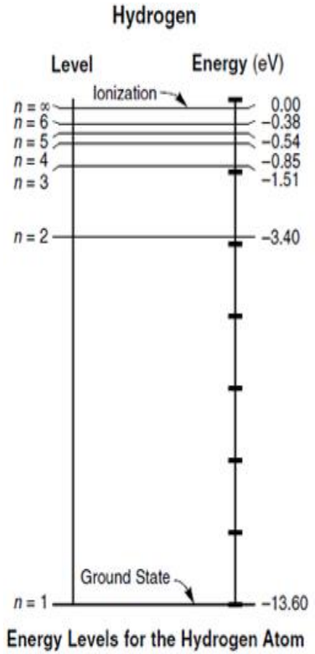
Cri@tividade e Física Perceptiva

Novas maneiras de "ver", "ser" e "interagir"
Realidade Virtual, Sonificação

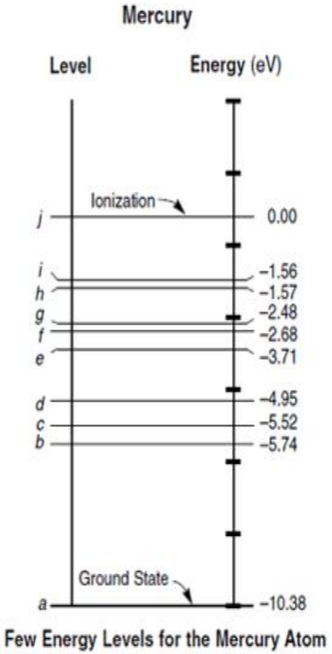




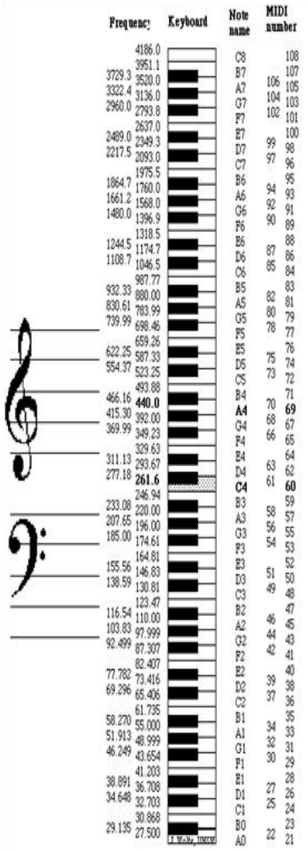




Energy Levels for the Hydrogen Atom



A Few Energy Levels for the Mercury Atom

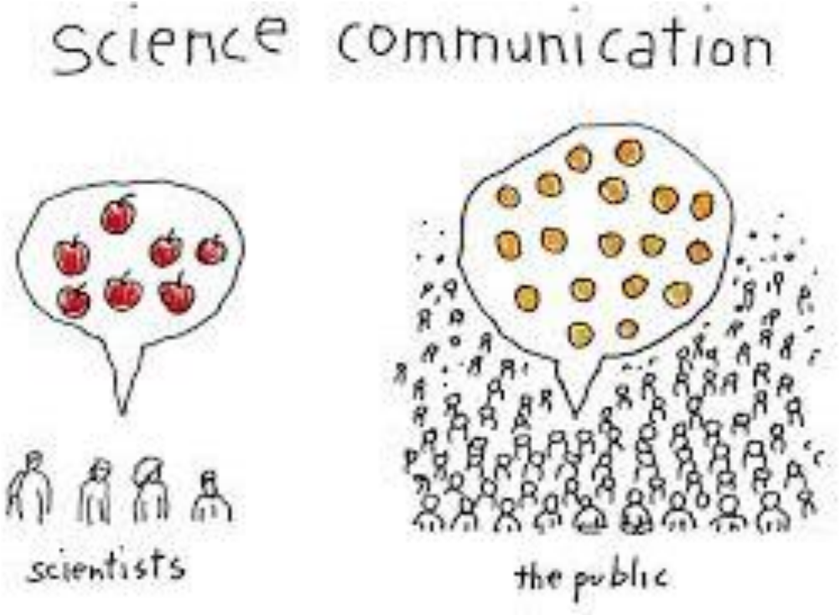


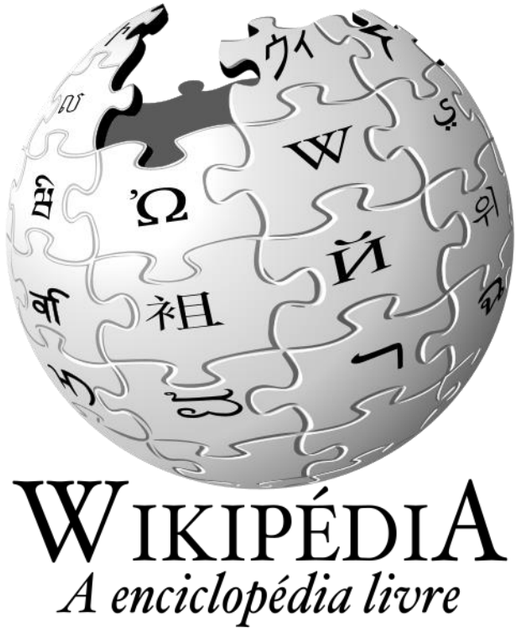
Com Gustavo Chagas e Paulo Vitor

Artecomciência: percepção pública, comunicação científica e processos criativos

1) Estimular a comunidade da Física na produção de conteúdo para comunicação científica

2) Interseções em arte e ciência





https://guides.library.upenn.edu/c.php?g=490107

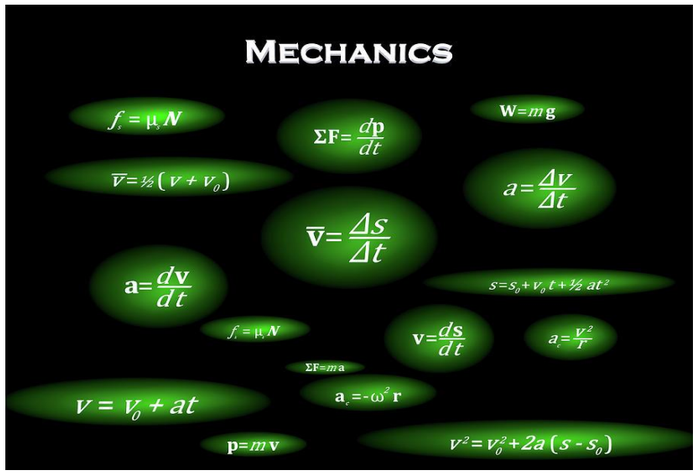
https://www.instagram.com/artecomciencia_usp/

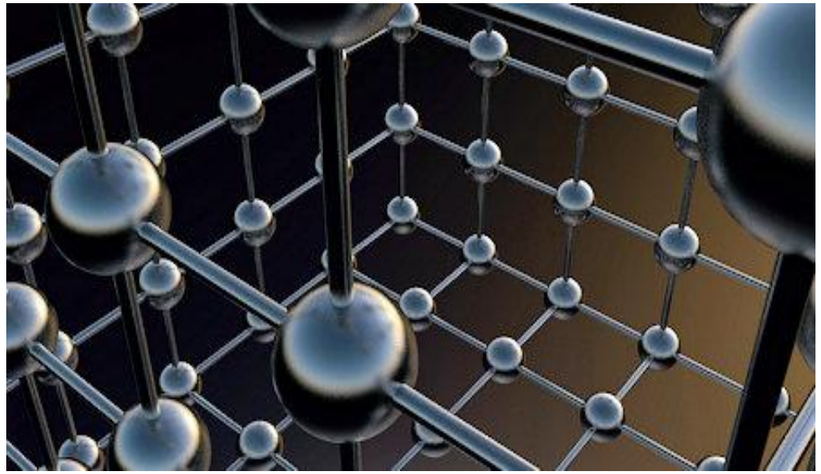
ESTRATÉGIAS ENSINO-APRENDIZAGEM RECURSOS E AVALIAÇÃO

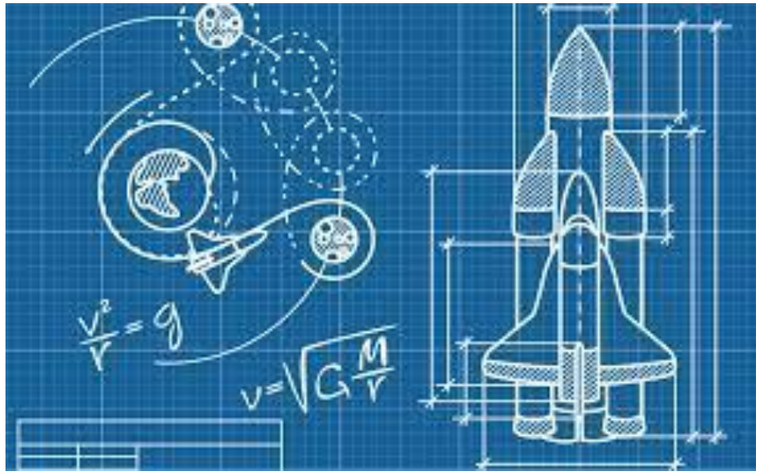
Apresentação do curso – segundo o "Júpiter"

"Apresentar aos alunos conceitos da Mecânica. Formular as Leis Fundamentais da Mecânica. Apresentar a relação entre o conceito de simetria e leis de conservação. Estudar interações específicas, como a interação gravitacional. Estudar rotações e referenciais não-inerciais."

Os estudantes aprovados na disciplina deverão ser capazes de formular, entender, equacionar e resolver problemas físicos relativos aos tópicos acima.







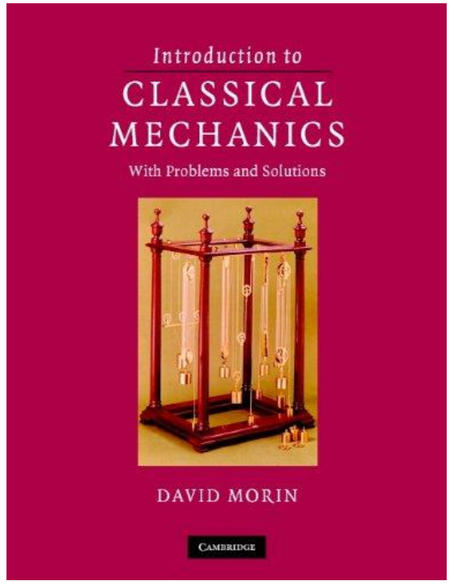
Física I - CCM

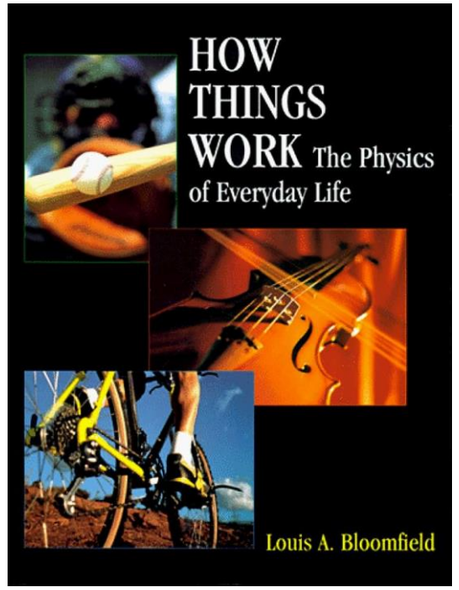
- Método: Fenômeno Físico - Formalismo - Aplicação
  - Demonstração e discussão do fenômeno físico
  - Modelo teórico
  - Aplicações no cotidiano (Fixação – Listas de exercícios)
  - Experimentações imersivas e lúdicas
  - Estratégias ensino-aprendizagem

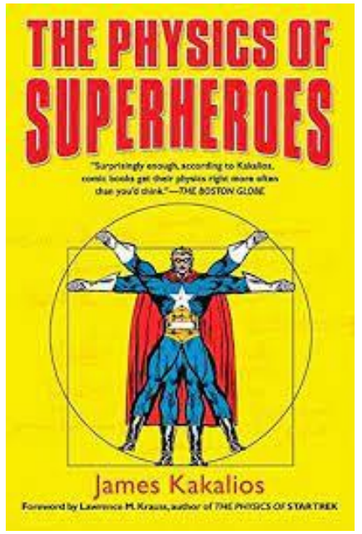
- Organização: Experiências + Fundamentos + Discussões

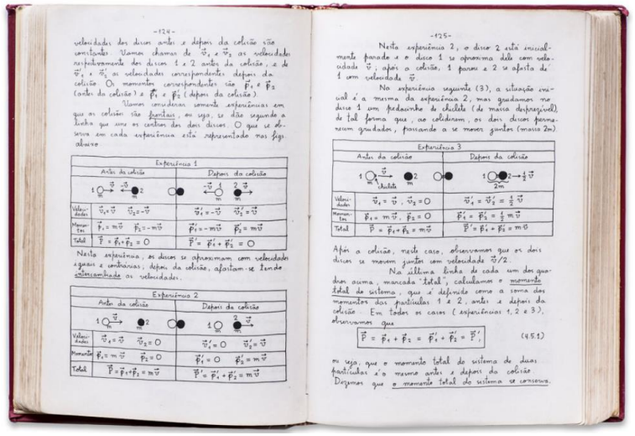
- Avaliação: 0.2*P1 + 0.3*P2 + 0.5*(Média_Entregas)

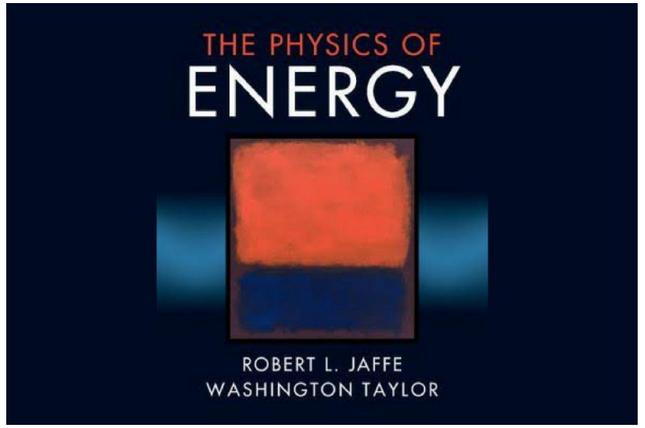
Bibliografia

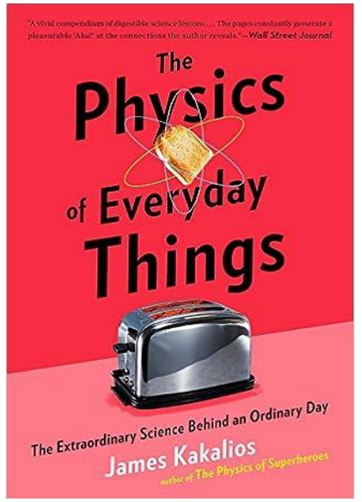




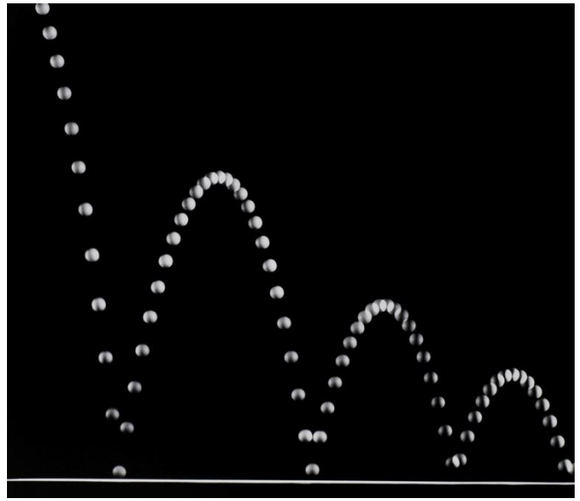


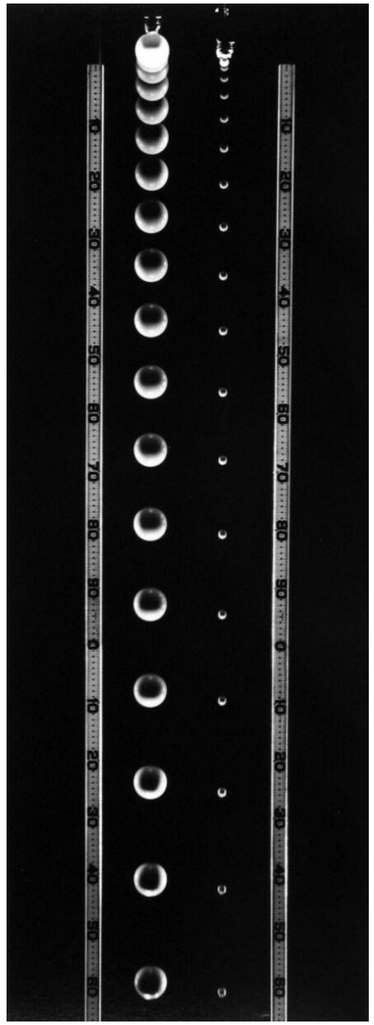


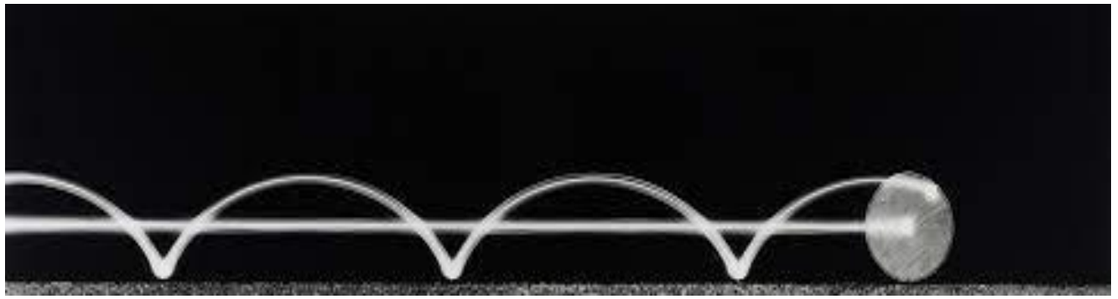


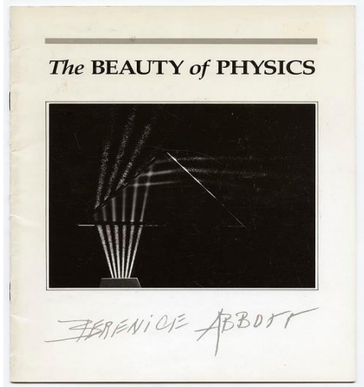


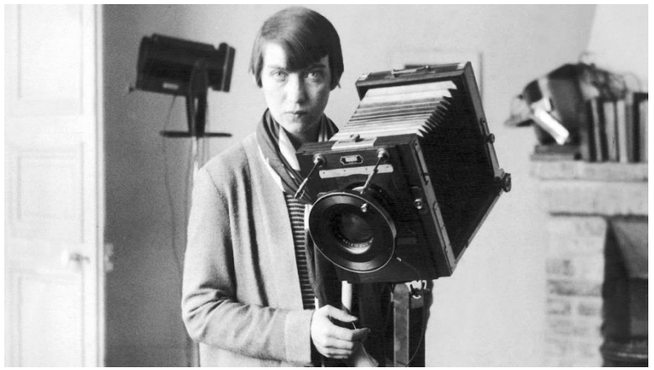
A beleza da Física por Berenice Abbott







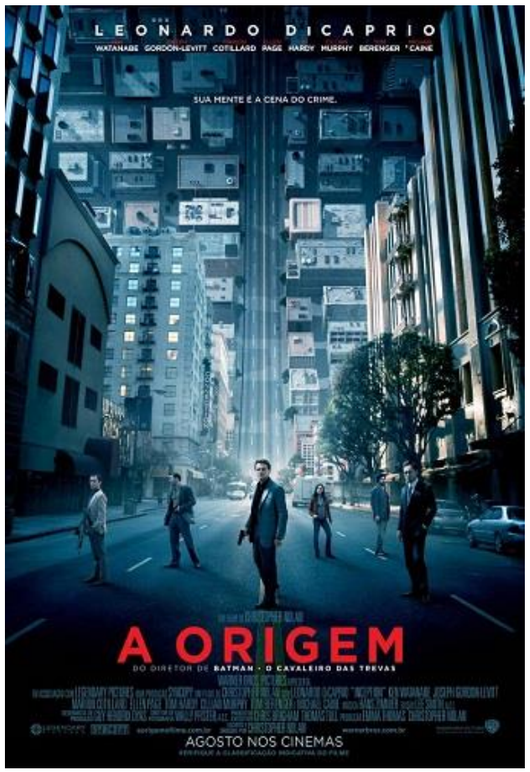




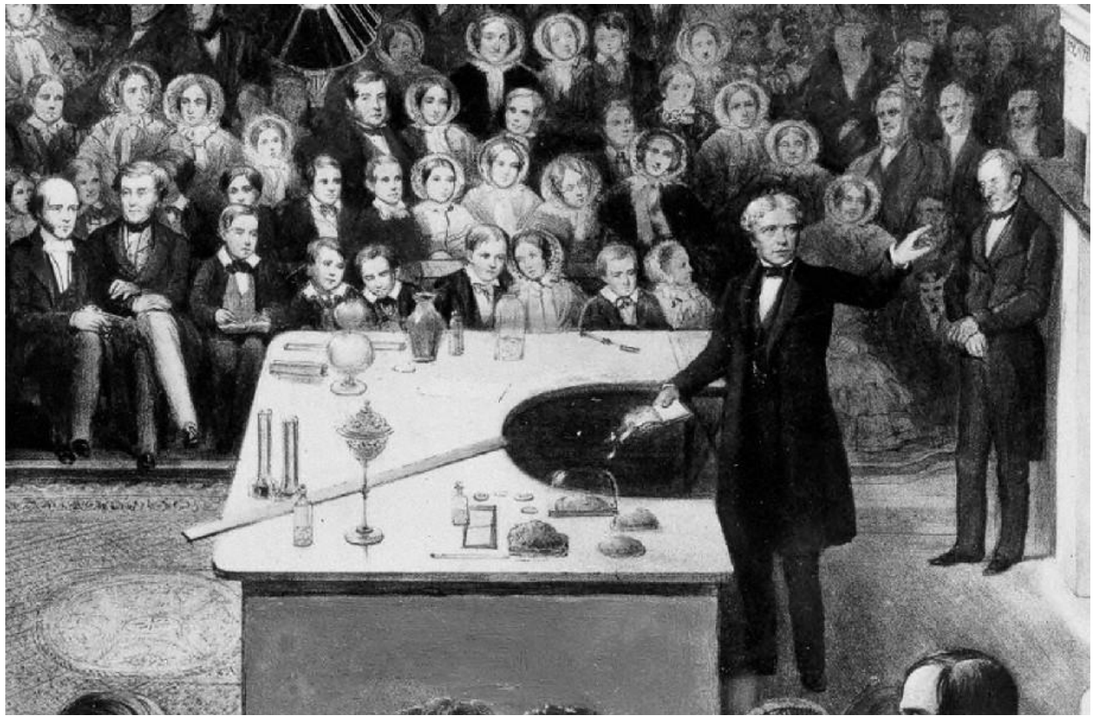
“a friendly interpreter between science and the layman,”

Segundo Cae: “a Física por Christopher Nolan”

“O objetivo prioritário da disciplina é maravilhar-se com a Física em nosso dia-dia e além dele”



Novas e velhas formas



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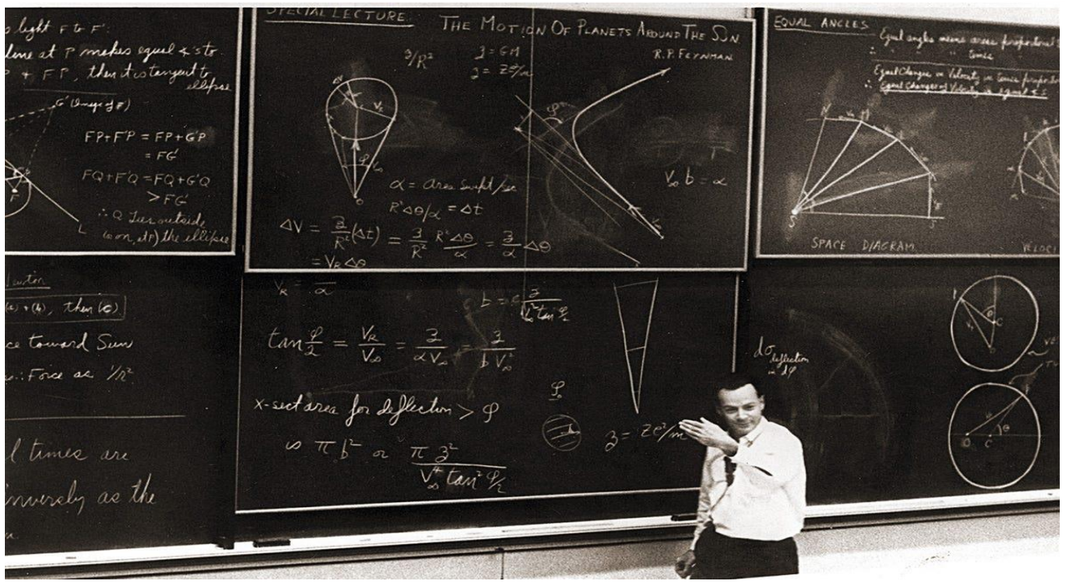

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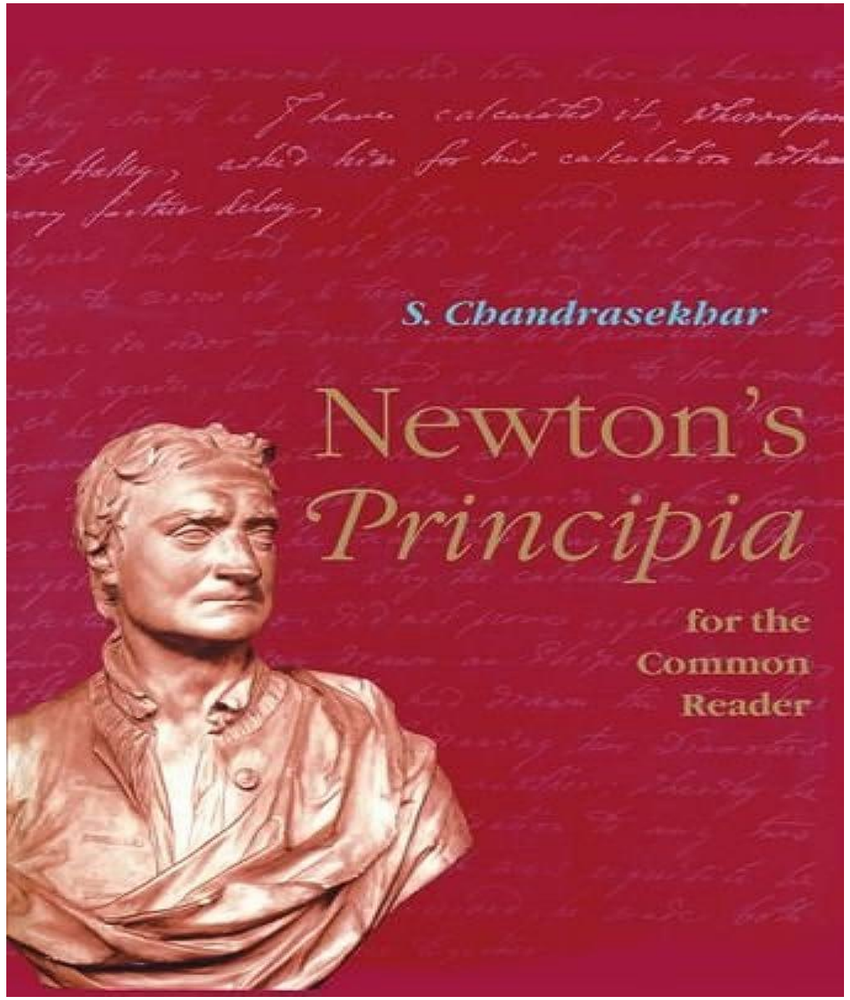
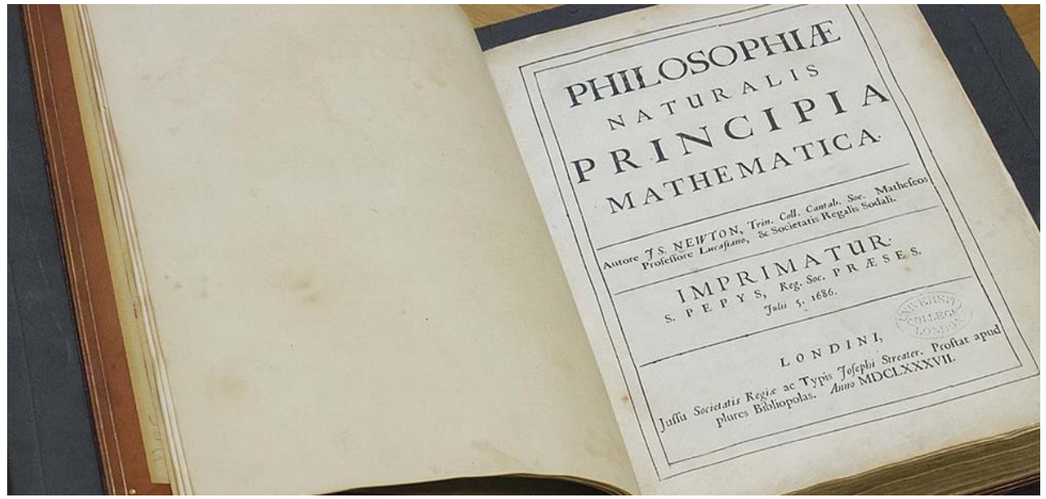




Sala Invertida - The Feynman Lectures on Physics

Feynman's Lectures on Physics - The Law of Gravitation

ITINERÁRIO: PROGRAMAÇÃO E DINÂMICA

Cronograma

DATA	aula nº	Segundas (14:00h - 15:45h) - Sala Turma 33	DATA	aula nº	Quartas (14:00h - 15:45h) - Sala Turma 33	DATA	aula nº	Quintas (14:00h - 15:45h) - Sala Turma 33	
21/08	1	Apresentação do Curso	23/08	2	Experimentação 1 - Escalas	24/08	3	Escalas	
28/08	4	Experimentação 2 - Mov. em 1 D	30/08	5	Mov. em 1D	31/08	6	Mov. em 1D	
04/09			06/08			07/09		SEMANA TRABALHO	
11/09	7	Experimentação 3 - Angry Birds	13/09	8	Mov. em 2D e 3D	14/09	9	Mov. em 2D e 3D	ENTREGA 1
18/09	10	Experimentação 4a - Dinâmica	20/09	11	Principios da Dinamica - Leis de Newton	21/09	12	Principios da Dinâmica - Leis de Newton	
25/09	13	Experimentação 4b - Principia	27/09	14	Principios da Dinâmica - Leis de Newton	28/09	15	Revisão - P1 - Check point - Projeto	
02/10		PROVA I	04/10	16	Experimentação 5 - Energia e Trabalho	05/10	17	Energia e Trabalho	
09/10	18	Energia e Trabalho	11/10	19	Energia e Trabalho	12/10		FERIADO - N. S. Aparecida	
16/10	20	Experimentação 6 - Física dos Desenhos Animados	18/10	21	Simetria e Conservação	19/10	22	Simetria e Conservação	ENTREGA 2
23/10	23	Experimentação 7 - Colisões	25/10	24	Colisões	26/10	25	Colisões	
30/10	26	Experimentação 8 - VR / Sonificação	01/11	27	Forças de Interação - Sala Invertida	02/11		FERIADO - FINADOS	
06/11	28	Forças de Interação	08/11	28	Revisão - P2 - Check point - Projeto	09/11		PROVA II	
13/11			15/11			16/11		SEMANA TRABALHO	
20/11		FERIADO - Consciência Negra	22/11	30	Experimentação 9 - Aprendizado de Máquina	23/11	31	Rotação e Momento Angular	ENTREGA 3
27/11	32	Física dos Esportes e Parques de Diversão	29/11	33	Rotação e Momento Angular	30/11	34	Experimentaçao 10 - Dança e Robótica	
04/12	35	Forças Inerciais	06/12	36	Forças Inerciais	07/12	37	Check point - Projeto	
11/12		PROJETOS	13/12		PROJETOS	14/12		VISTA	ENTREGA 4
18/12		PROVA - SUB - VISTA	20/12		VISTA	21/12			

Cronograma

Agosto / Setembro / Outubro / Novembro / Dezembro

Cinemática

Dinâmica

Conservação Energia

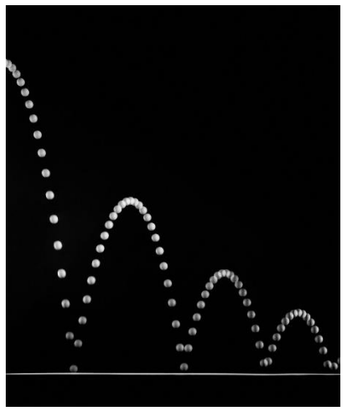
Conservação Momentum

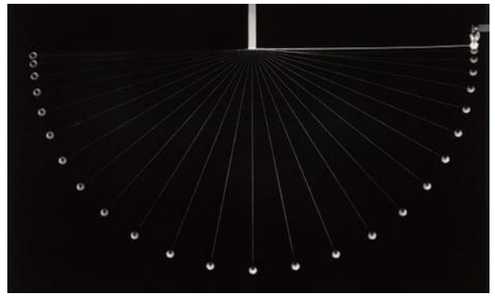
Momento Angular

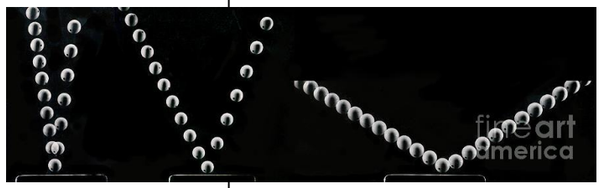
Corpos Rígidos

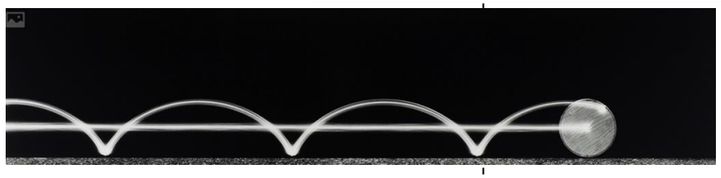
Projeto

Finalização









ENTREGA 1 – 17/09

ENTREGA 2 – 22/10

ENTREGA 3 – 26/11

ENTREGA 4 – 13/12

PROVA I – 02/10

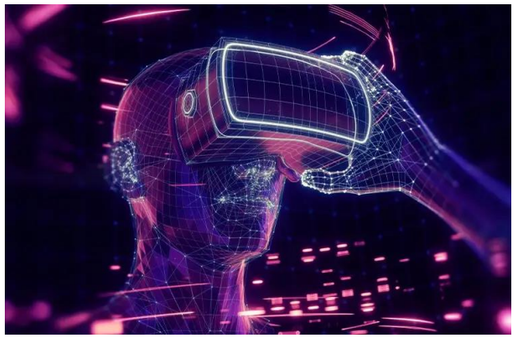
PROVA II – 09/11

Experiência 1 - Escalas

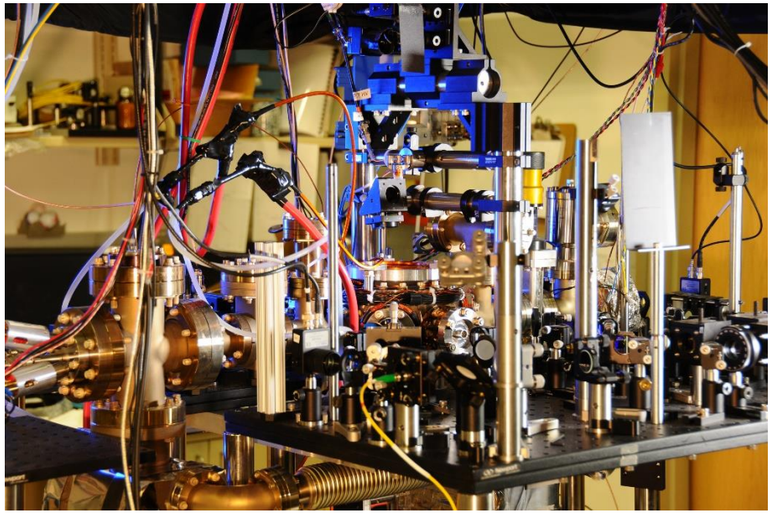
Guerra de Papel

Material:

Folhas A4, Jornal ou Caderno

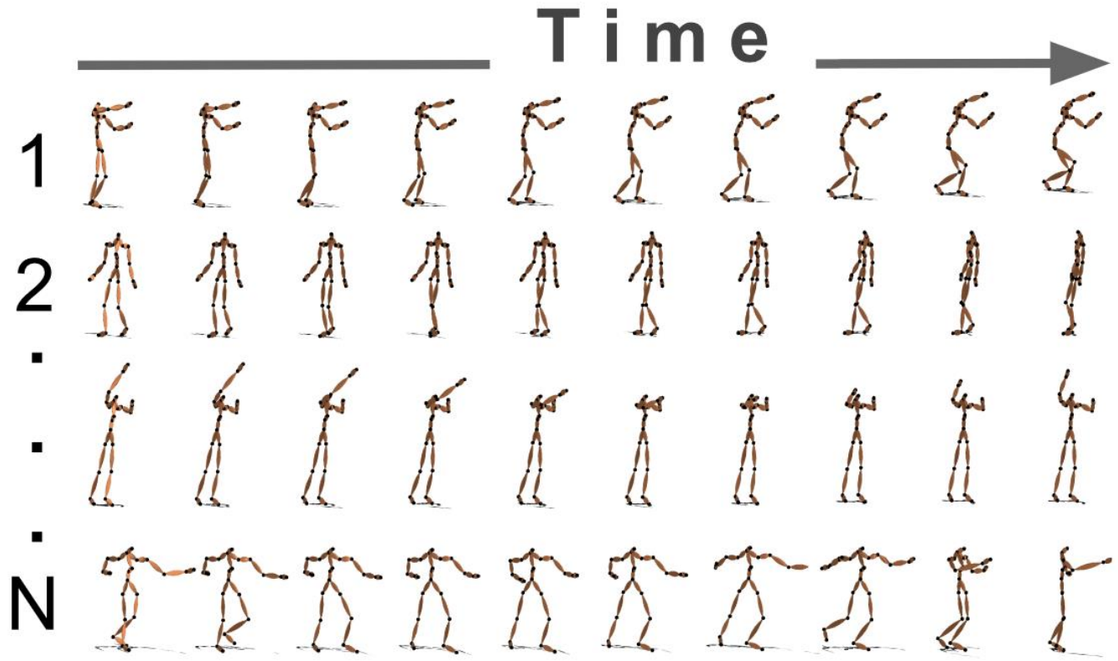


Tempo



Experiência 2 – Movimento 1D

Física do movimento

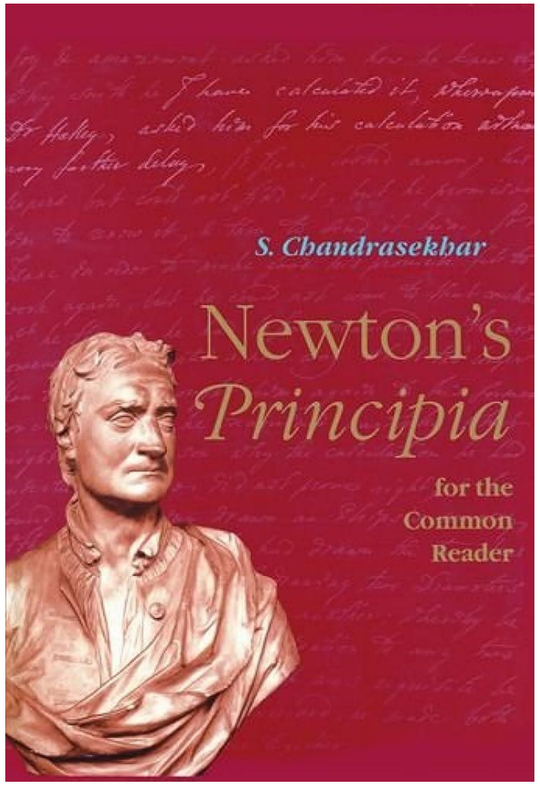


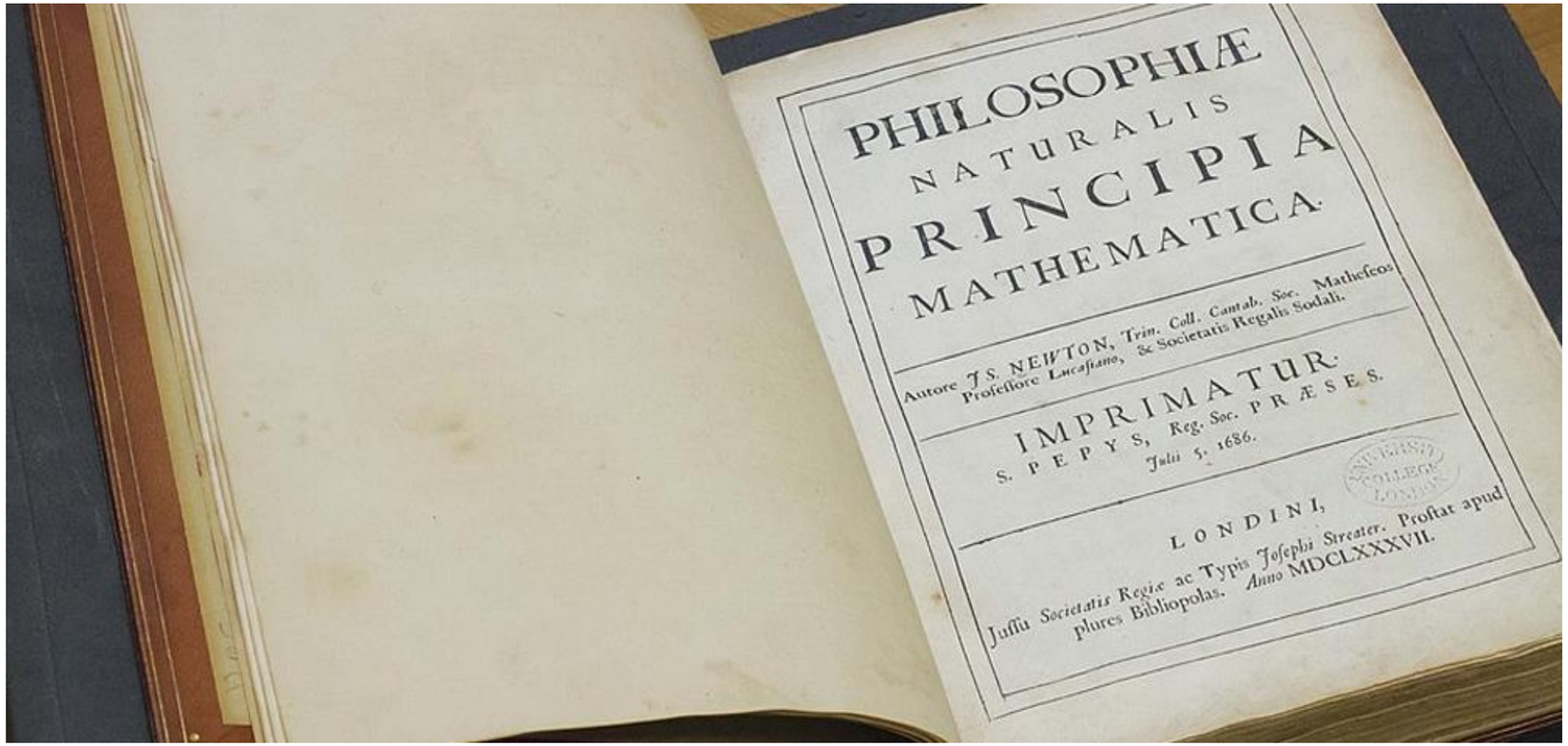
*Experiência 3 – Movimento 2D & 3D

Angry birds

*Experiência 4 – Princípios da dinâmica

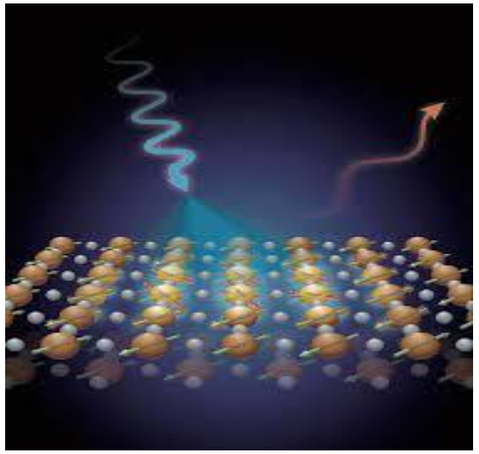
Principia Trivia e Encenação





De sala de aula à Wikipédia

Quanto conhecimento prévio você realmente precisa para explicar um conceito/fenômeno em física?



WIKIPÉDIA
A enciclopédia livre

1) Compartilhe seu conceito favorito com o grupo

2) Escolham a mais "interessante"

3) Identifiquem qual o conceito físico central

4) O que temos na Wikipédia sobre esse conceito ?

5) Revise a versão em português desse conceito na Wikipédia.

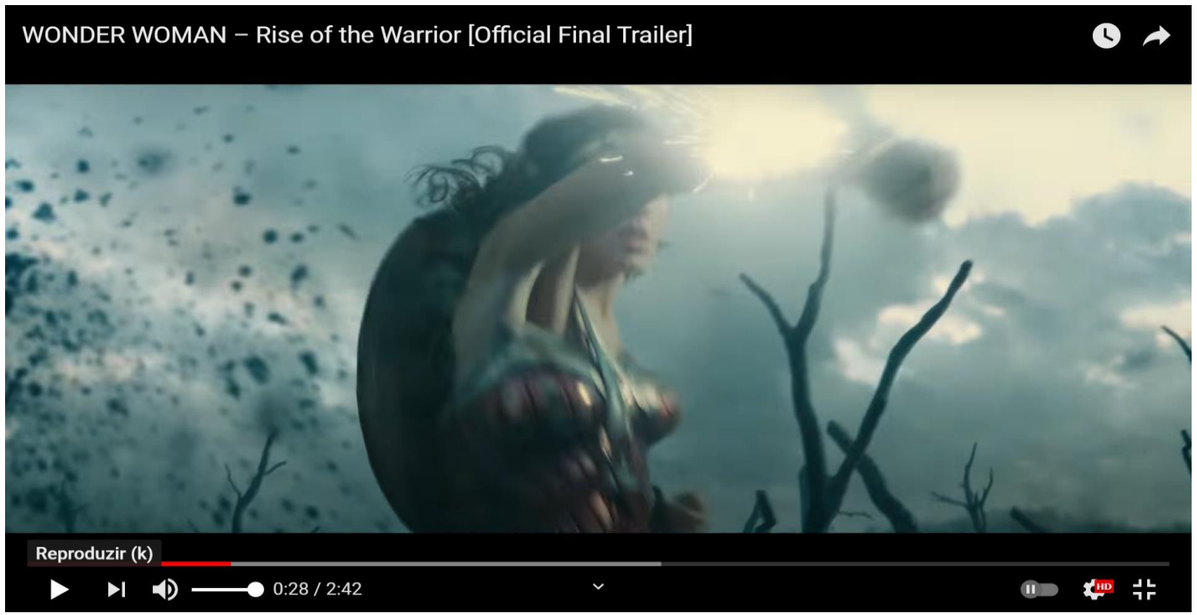
Experiência 5 - Energia

Objetivos de desenvolvimento sustentável (Agenda das Nações Unidas em 2015 para 2030)

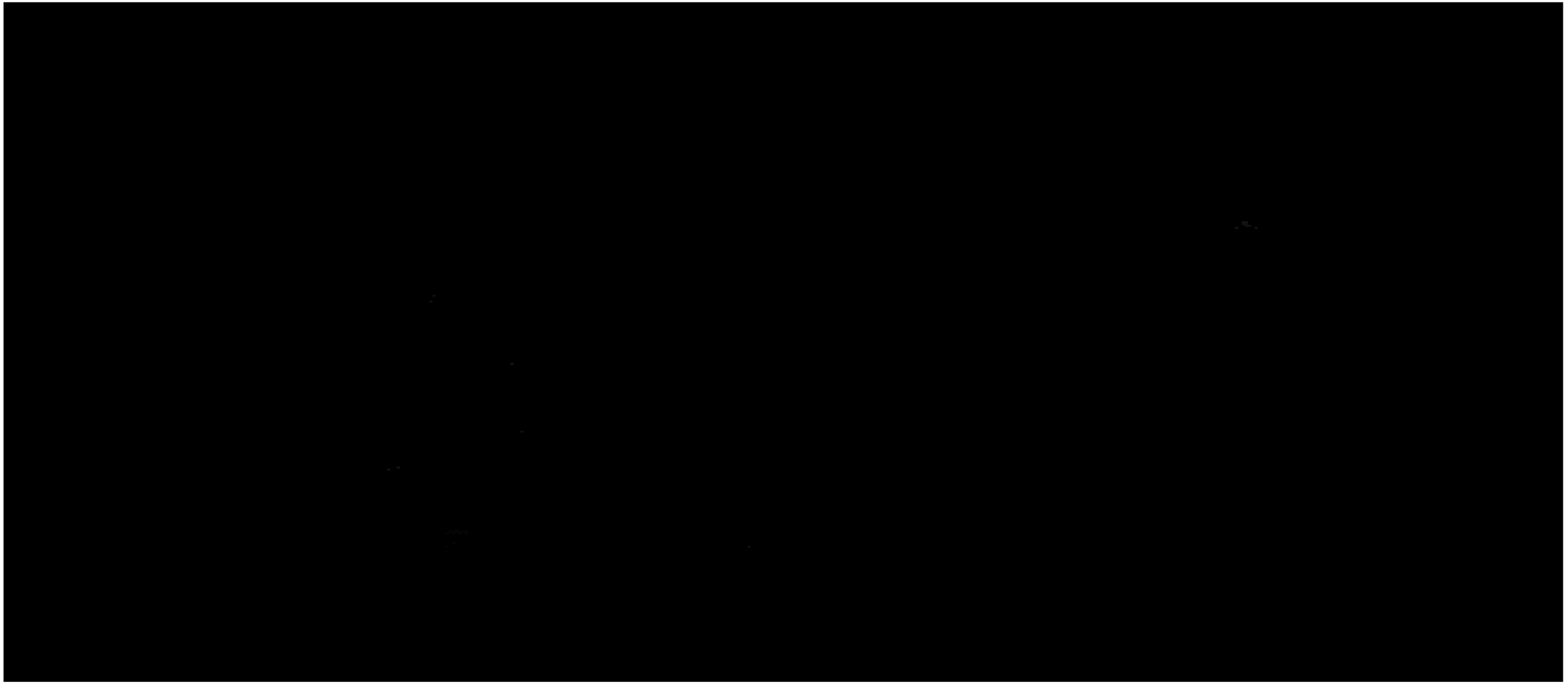
Os Objetivos de Desenvolvimento Sustentável são uma chamada universal à ação para erradicar a pobreza, proteger o planeta e melhorar a vida e as perspectivas de todos, em todos os lugares.

*Experiência 6 – Simetria & leis de conservação

Física dos Desenhos Animados e Super-herois



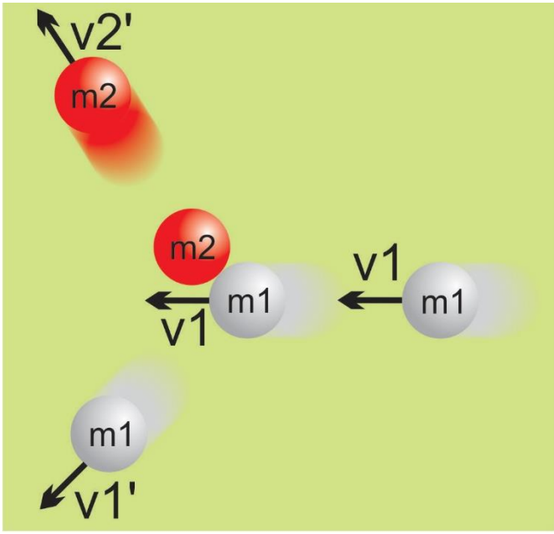
Experiência 6 – Simetria & leis de conservação



Experiência 6 – Simetria & leis de conservação

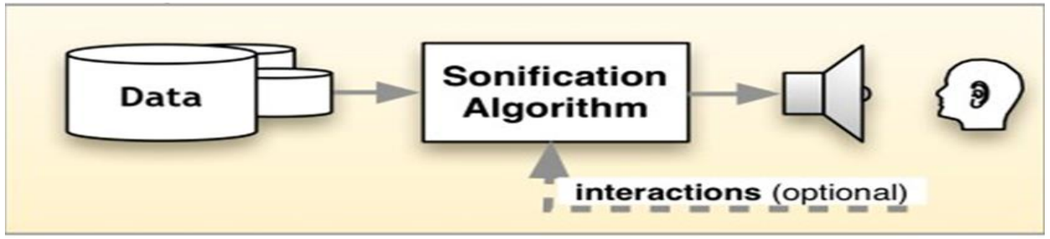
Experiência 7 - Colisões

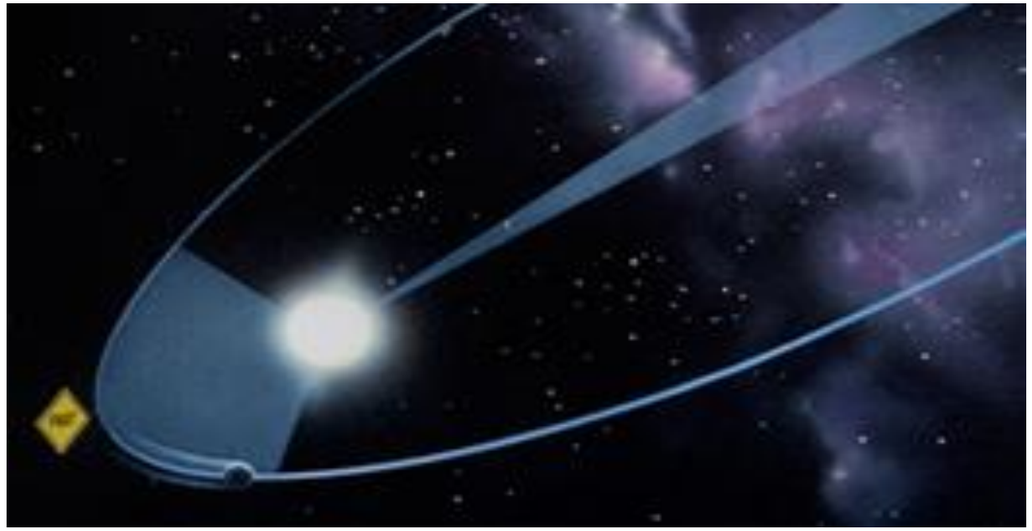
Física da Sinuca

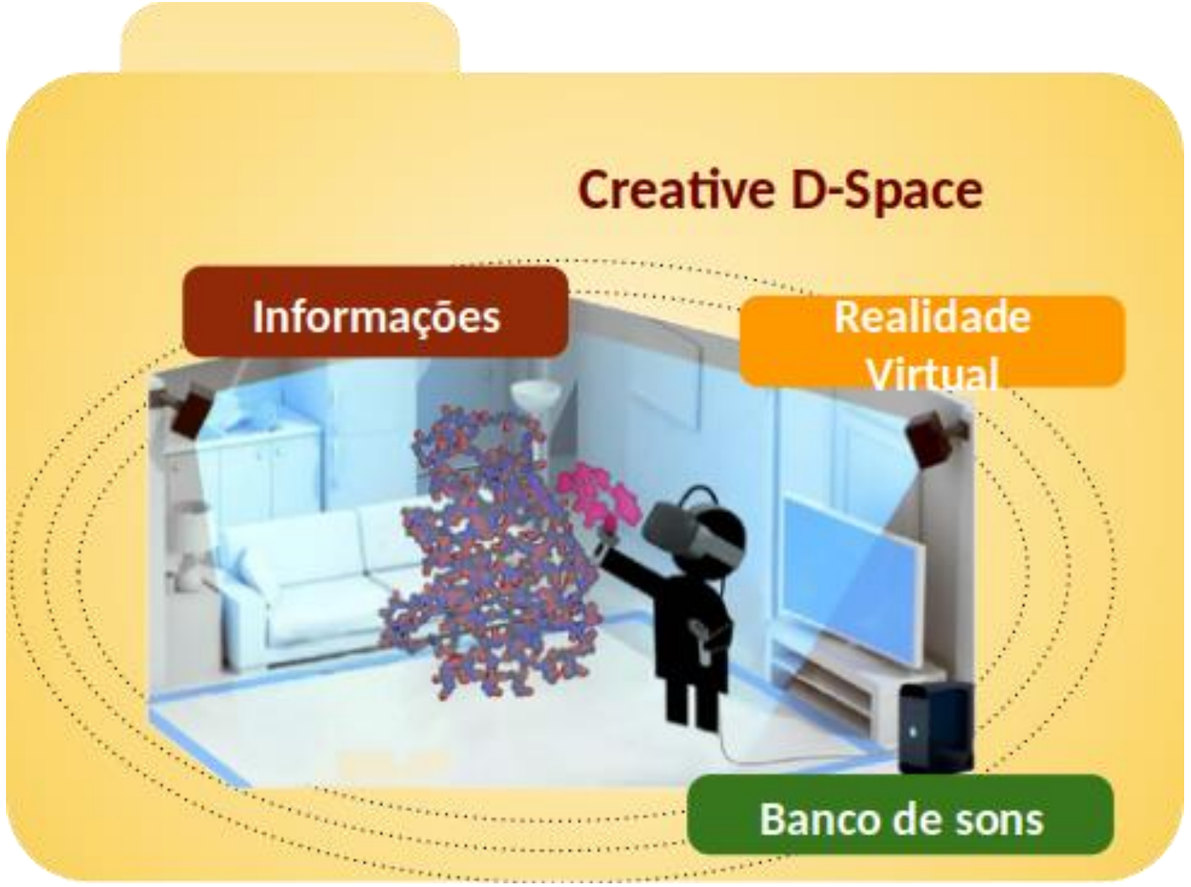


Experiência 8 – Interações específicas
Interações atômicas & gravidade

VR e Sonificação



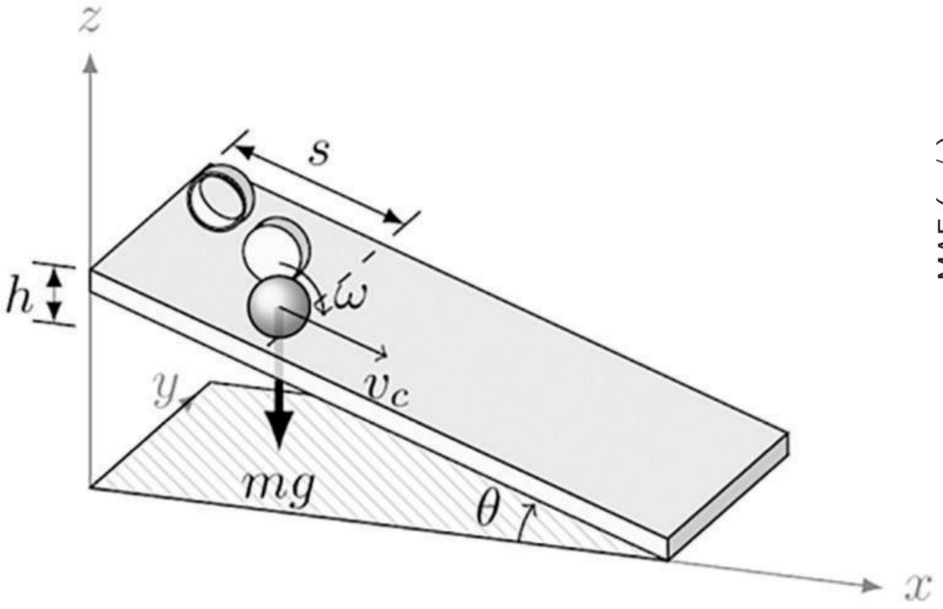


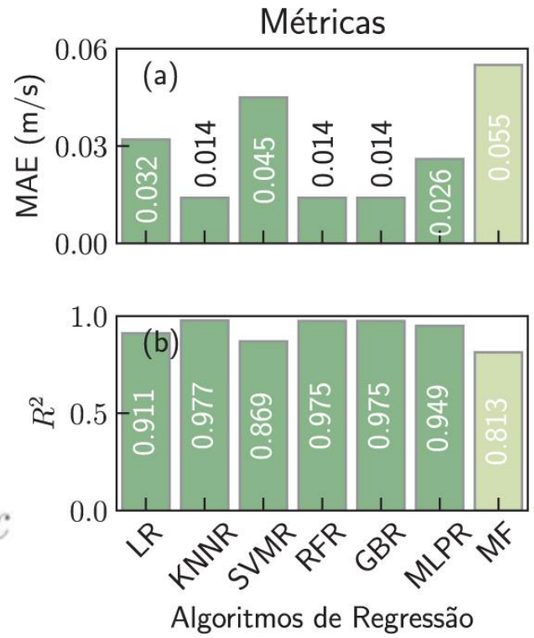


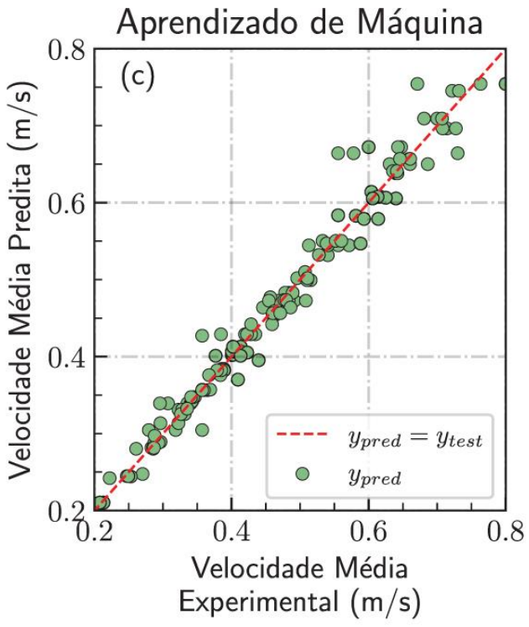
*Experiência 9 – Dinâmica de corpos rígidos

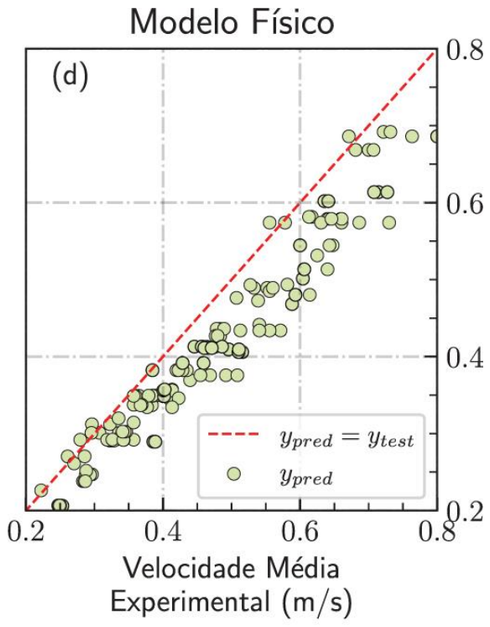
As máquinas podem nos ensinar física ?

Podemos aprender física com as máquinas ?







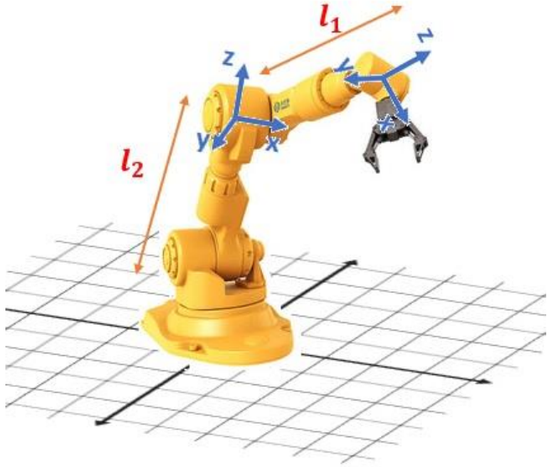


https://doi.org/10.1590/1806-9126-RBEF-2022-0214

Experiência 10 – Rotação & Momento Angular

Dança e robótica

Física dos Parques de Diversão



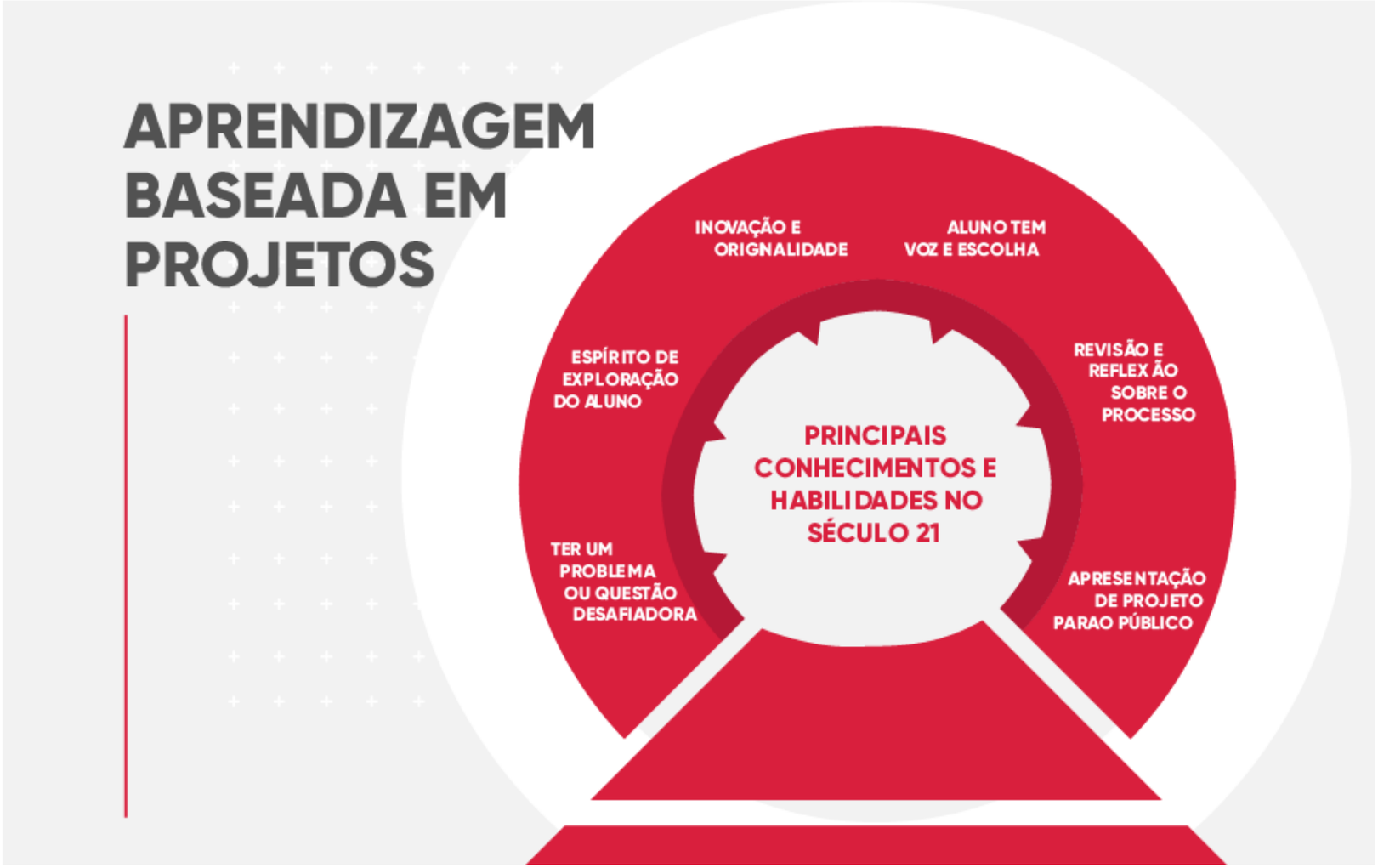
PROVAS
P1 - 02/10
P2 - 09/11

Coerência & Consistência:

2 Questões das listas sugeridas

1 Questão conceitual ou articulada com o projeto

PROJETO
14 & 15/12



*Missão – CCM1 – Aplicar conceitos/fenômenos de Física 1 na exploração de Exoplanetas …

Escolha do formato:

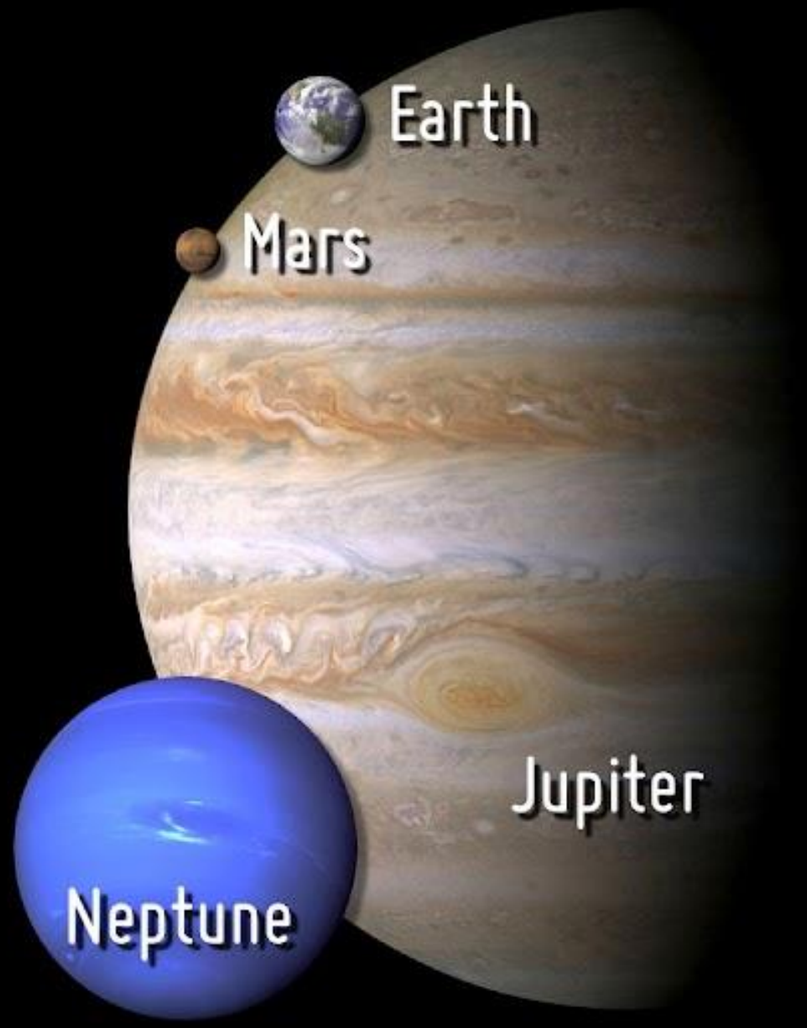
a) Todos irão ao mesmo planeta (divisões)

b) 6 missões para distintos planetas

Potentially Habitable Exoplanets

PHL

Sorted by Distance from Earth



Artistic representations. Earth, Mars, Jupiter, and Neptune for scale. Distance from Earth in light years (ly) is between brackets.

CREDIT: PHL @ UPR Arecibo (phl.upr.edu) Jan 5, 2023

Projeto

PHL @ UPR Arecibo - The Habitable Exoplanets Catalog

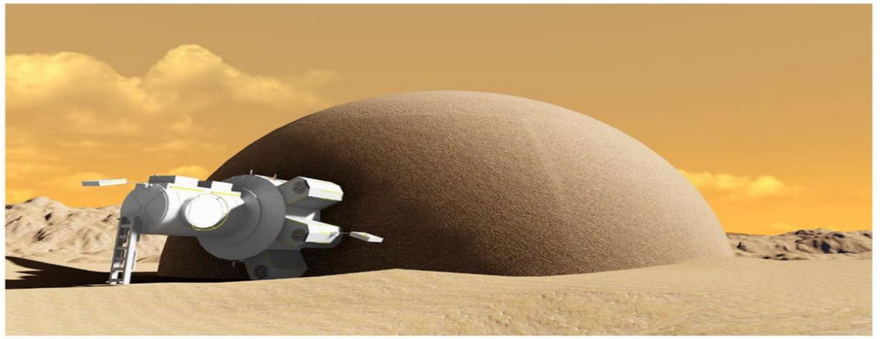
Conservative Sample of Potentially Habitable Exoplanets

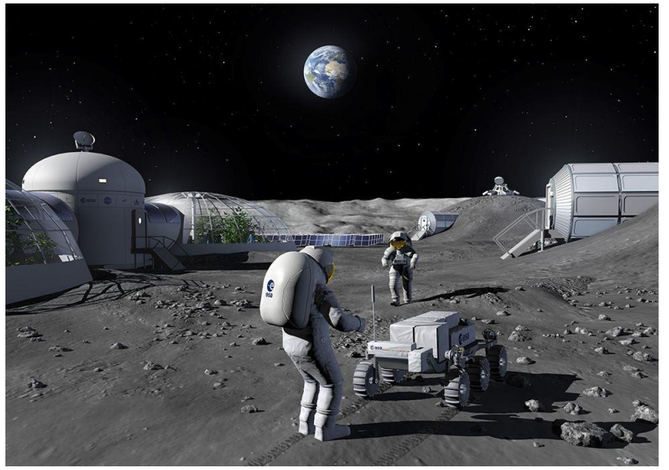
This is a list of the exoplanets that are more likely to have a rocky composition and support surface liquid water (*i.e.*, 0.5 < Planet Radius ≤ 1.6 Earth radii or 0.1 < Planet Minimum Mass ≤ 3 Earth masses). They are represented artistically in the top image.

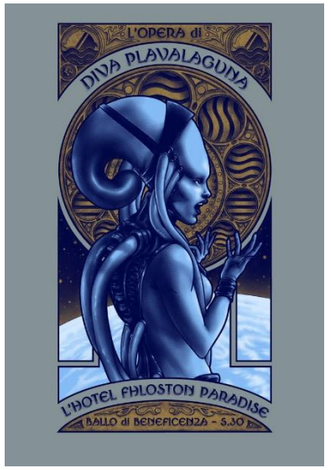
Name	Type	Mass (M_E)	Radius (R_E)	Flux (S_E)	T_{surf} (K)	Period (days)	Distance (ly)	ESI
001. Teegarden's Star b	M-Warm Terran	≥ 1.05	~ 1.02	1.15	~ 298	4.9	12	0.95
002. TOI-700 d	M-Warm Terran	~ 1.57	1.14	0.87	~ 278	37.4	101	0.93
003. Kepler-1649 c	M-Warm Terran	~ 1.20	1.06	1.23	~ 303	19.5	301	0.92
004. TRAPPIST-1 d	M-Warm Subterran	0.39	0.78	1.12	~ 296	4.0	41	0.91
005. LP 890-9 c (N)	M-Warm Terran	—	1.37	0.91	~ 281	8.5	106	0.89
006. Proxima Cen b	M-Warm Terran	≥ 1.27	~ 1.08	0.70	~ 257	11.2	4.2	0.87
007. K2-72 e	M-Warm Terran	~ 2.21	1.29	1.30	~ 307	24.2	217	0.87
008. GJ 1002 b (N)	M-Warm Terran	≥ 1.08	~ 1.03	0.67	~ 261	10.3	16	0.86
009. GJ 1061 d	M-Warm Terran	≥ 1.64	~ 1.15	0.69	~ 247	13.0	12	0.86
010. GJ 1061 c	M-Warm Terran	≥ 1.74	~ 1.18	1.45	~ 311	6.7	12	0.86
011. Ross 128 b	M-Warm Terran	≥ 1.40	~ 1.11	1.48	~ 317	9.9	11	0.86
012. GJ 273 b	M-Warm Terran	≥ 2.89	~ 1.51	1.06	~ 292	18.6	12	0.85
013. Kepler-296 e	M-Warm Terran	~ 2.96	1.52	1.00	~ 282	34.1	544	0.85
014. TRAPPIST-1 e	M-Warm Terran	0.69	0.92	0.65	~ 258	6.1	41	0.85
015. Kepler-442 b	K-Warm Terran	~ 2.36	1.35	0.70	~ 263	112.3	1193	0.84
016. GJ 667 C f	M-Warm Terran	≥ 2.54	~ 1.45	0.56	~ 249	39.0	24	0.76
017. Kepler-62 f	K-Warm Terran	—	1.41	0.41	~ 230	267.3	981	0.68
018. TRAPPIST-1 f	M-Warm Terran	1.04	1.04	0.37	~ 225	9.2	41	0.68
019. Teegarden's Star c	M-Warm Terran	≥ 1.11	~ 1.04	0.37	~ 225	11.4	12	0.68
020. Kepler-1229 b	M-Warm Terran	~ 2.54	1.40	0.32	~ 217	86.8	865	0.62
021. Kepler-186 f	M-Warm Terran	~ 1.71	1.17	0.29	~ 212	129.9	579	0.61
022. GJ 667 C e	M-Warm Terran	≥ 2.54	~ 1.45	0.30	~ 213	62.2	24	0.60
023. GJ 1002 c (N)	M-Warm Terran	≥ 1.36	~ 1.10	0.26	~ 205	21.2	16	0.58
024. TRAPPIST-1 g	M-Warm Terran	1.32	1.13	0.25	~ 204	12.4	41	0.58

Projetando futuros

- Arquitetura da base (Infraestrutura)
- Processos Químicos e Sobrevivência
- Impacto no corpo humano
- Mobilidade
- Energia e sustentabilidade
- Robótica
- Esportes & Entretenimento







Física (Bio / Mat / Química / Geo / Engenharias / Divulgação)

Entregáveis

Missão - Exoplanetas

- Desenvolvimento de objetos de aprendizagem para Ensino Médio
- Infográfico / Mangá / Wikipédia
- Divulgação científica (podcast, vídeo, …)

Sumário – 21/08/2023

- Paixão pela Física
- Apresentação do curso
- Tour sobre as atividades a serem realizadas

Devolutiva:

- Como foi a aula hoje ? (Moodle)

https://forms.gle/TNRKfLb9stgG6b5FA