

Atomic Physics

Introduction







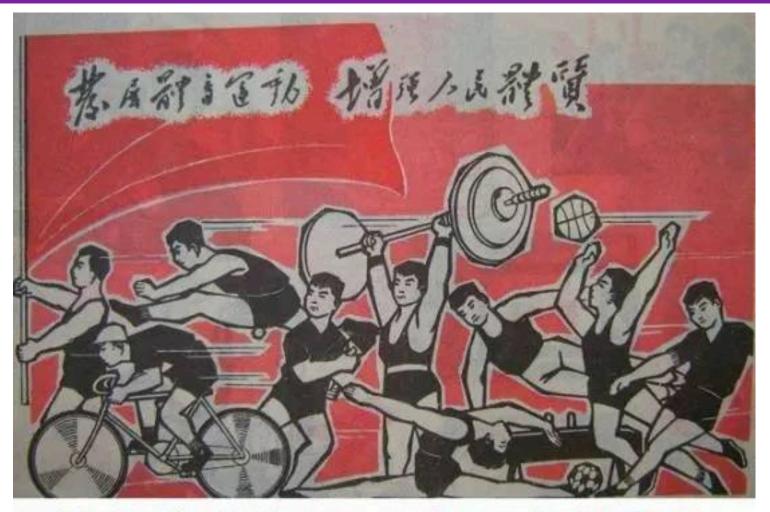




这是当老师前, 我眼中的学生。



当老师之前,满怀理想的我,哪

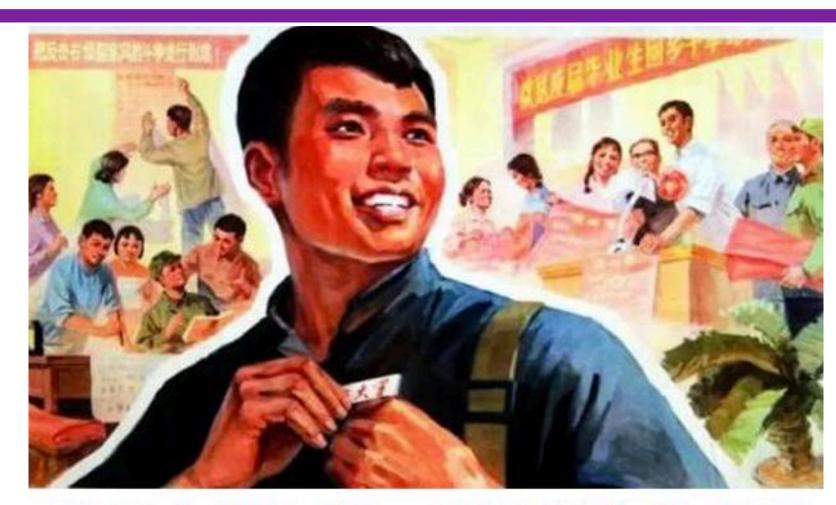


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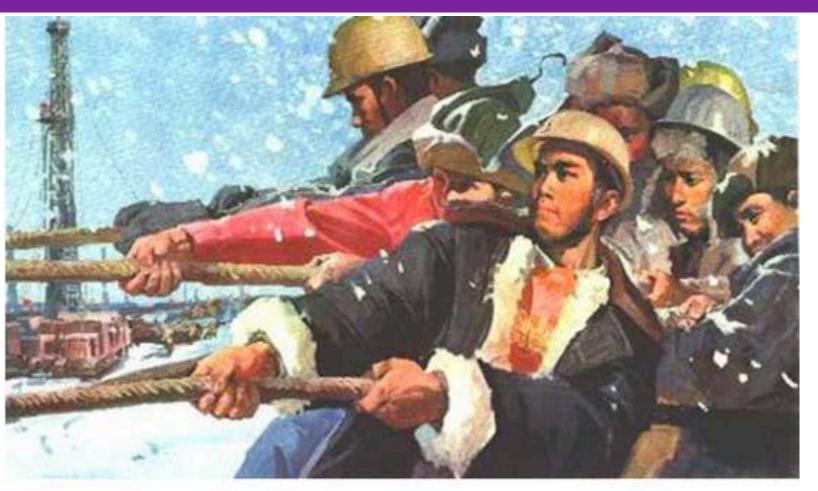


当老师之后, 面对现实的豫神





这是上课之前,我跟学生的关系



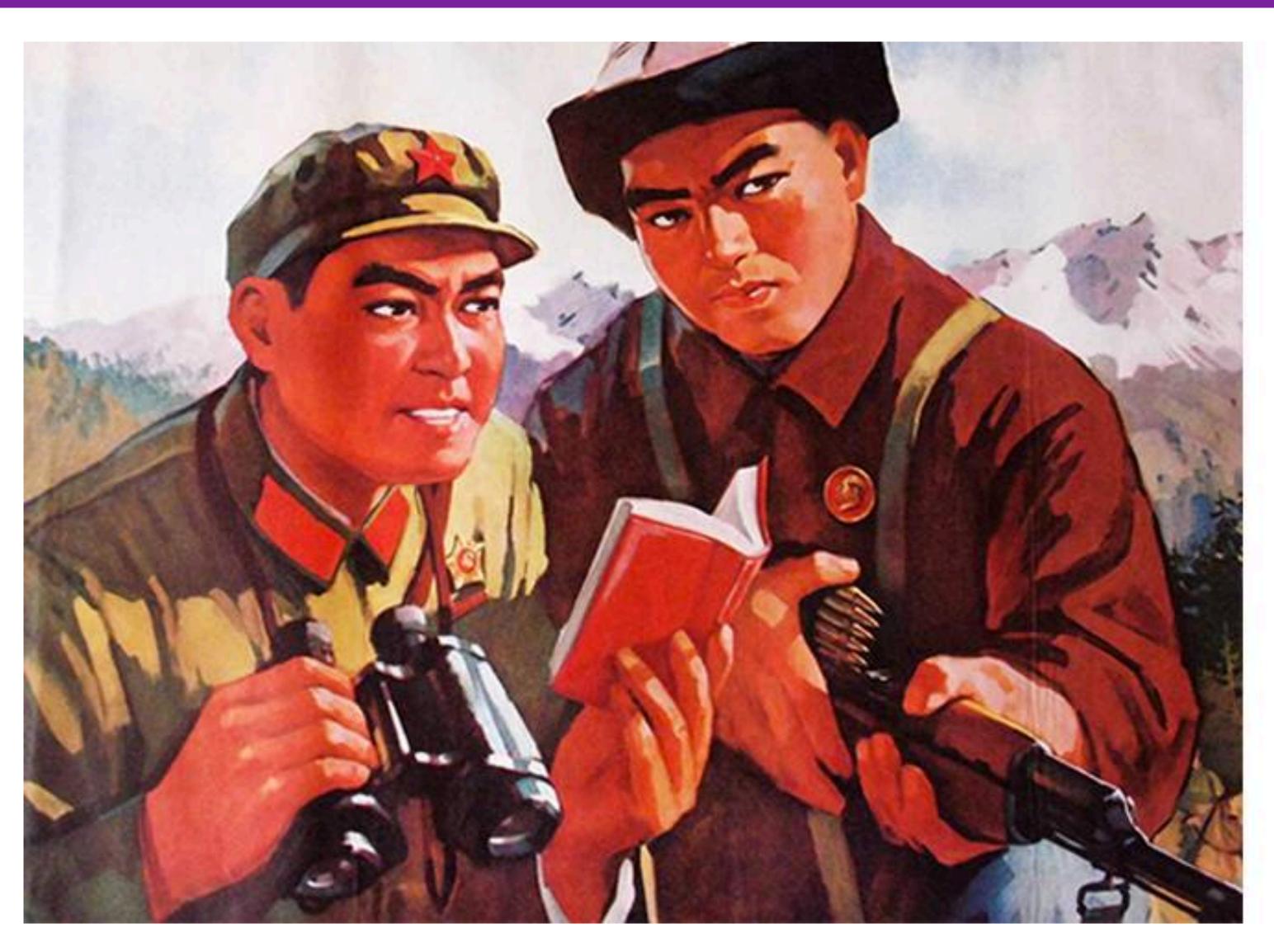
这是上课之时, 我跟学生的关系



这是下课之后, 我跟学生的美添

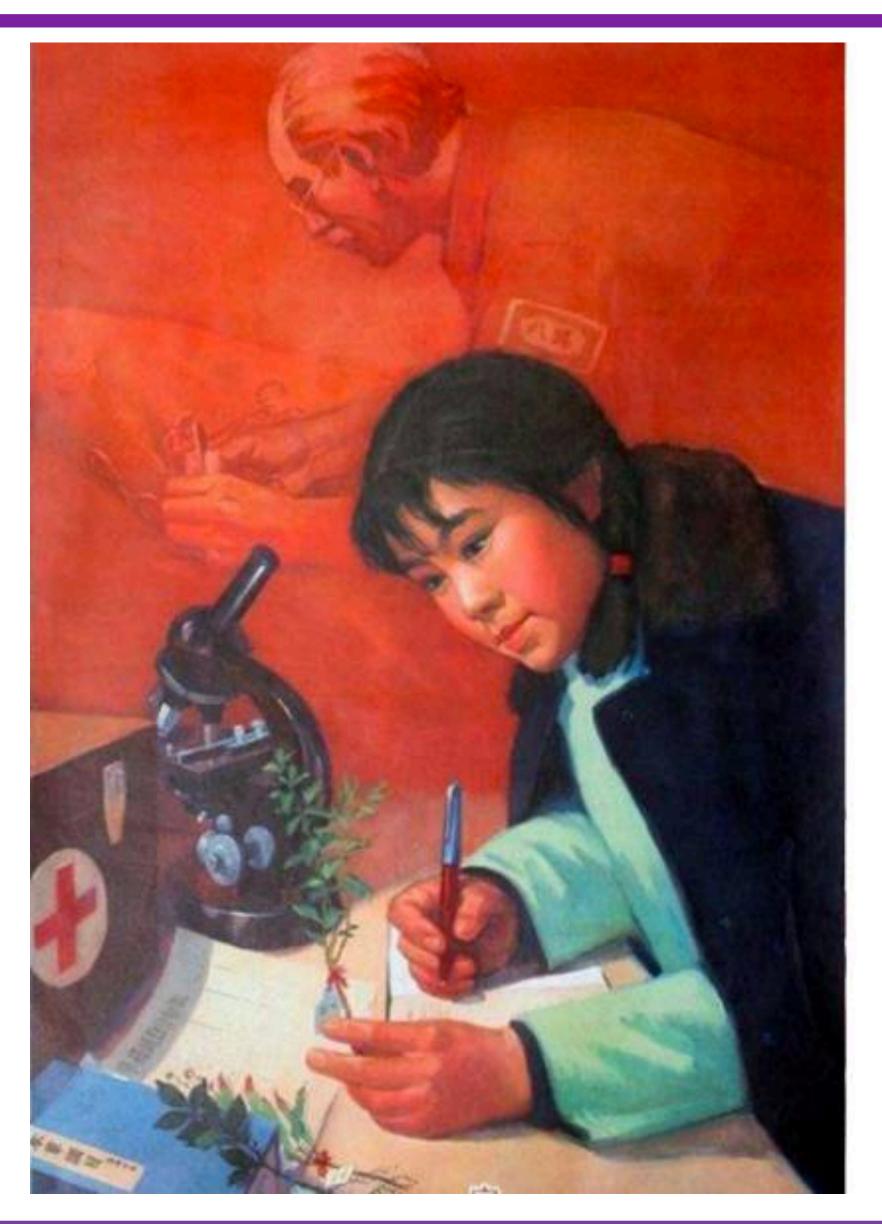
22/02/2021



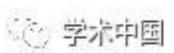


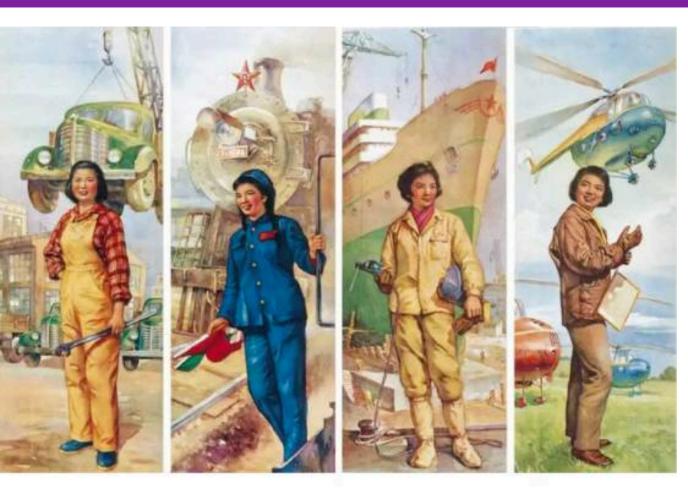
,弊为 听'了 觉我阻 都的止 进视学 化觉生





课因 '为 我经 的常 抵熬 抗夜 力加 变班 强备





以前我很羡慕那些将事业跟生活 分开的老师,不仅事业成功,生 活也过的有滋有味。觉得他们才 是生活的赢家。

后来我发现,一名老师,如果能培养出考试不作弊,课上不淘气,上课很积极,不点名,不迟到,看见老师能问好,知道写论文的时候自己查资料的学生,才是真正的生活的赢家!

How to be a good student



中华人民共和国教育部

教高函〔2018〕8号

教育部关于狠抓新时代全国高等学校本科教育工作会议精神落实的通知

2.加强学习过程管理。各高校要全面梳理各门课程的教学内容,淘汰"水课"、打造"金课",合理提升学业挑战度、增加课程难度、拓展课程深度,切实提高课程教学质量。要结合办学实际修订本科人才培养方案,切实把本科教育工作会议的精神、要求落实到学校人才培养各项工作、各个环节中,新方案要从2018级学生开始实施,持续抓四年、全程管到位,努力使每一级在校生都受益。要切实加强学习过程考核,加大过程考核成绩在课程总成绩中的比重,严格考试纪律、严把毕业出口关,坚决取消"清考"制度。

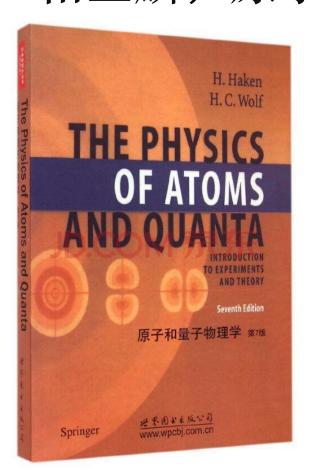
Class requirements

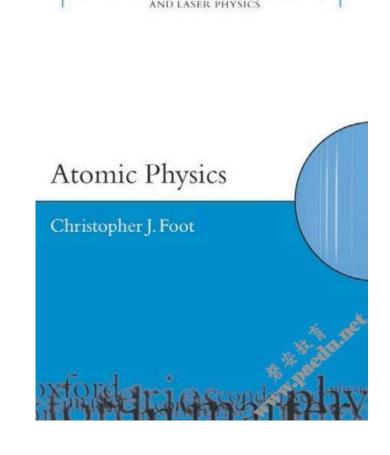


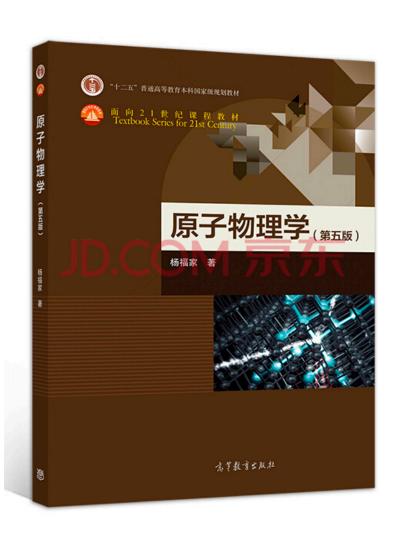
- √ Quiz+Homework (XX%)
- √ Final examination (100-XX%)
- √ References
 - H. Haken and H. C. Wolf, The physics of Atom and Quanta
 - C. J. Foot, Atomic Physics

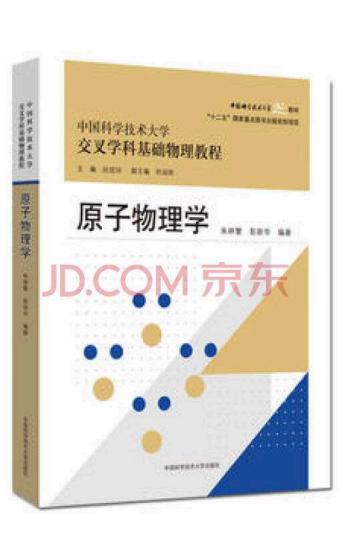
杨福家,原子物理学第四版

褚圣麟,原子物理学





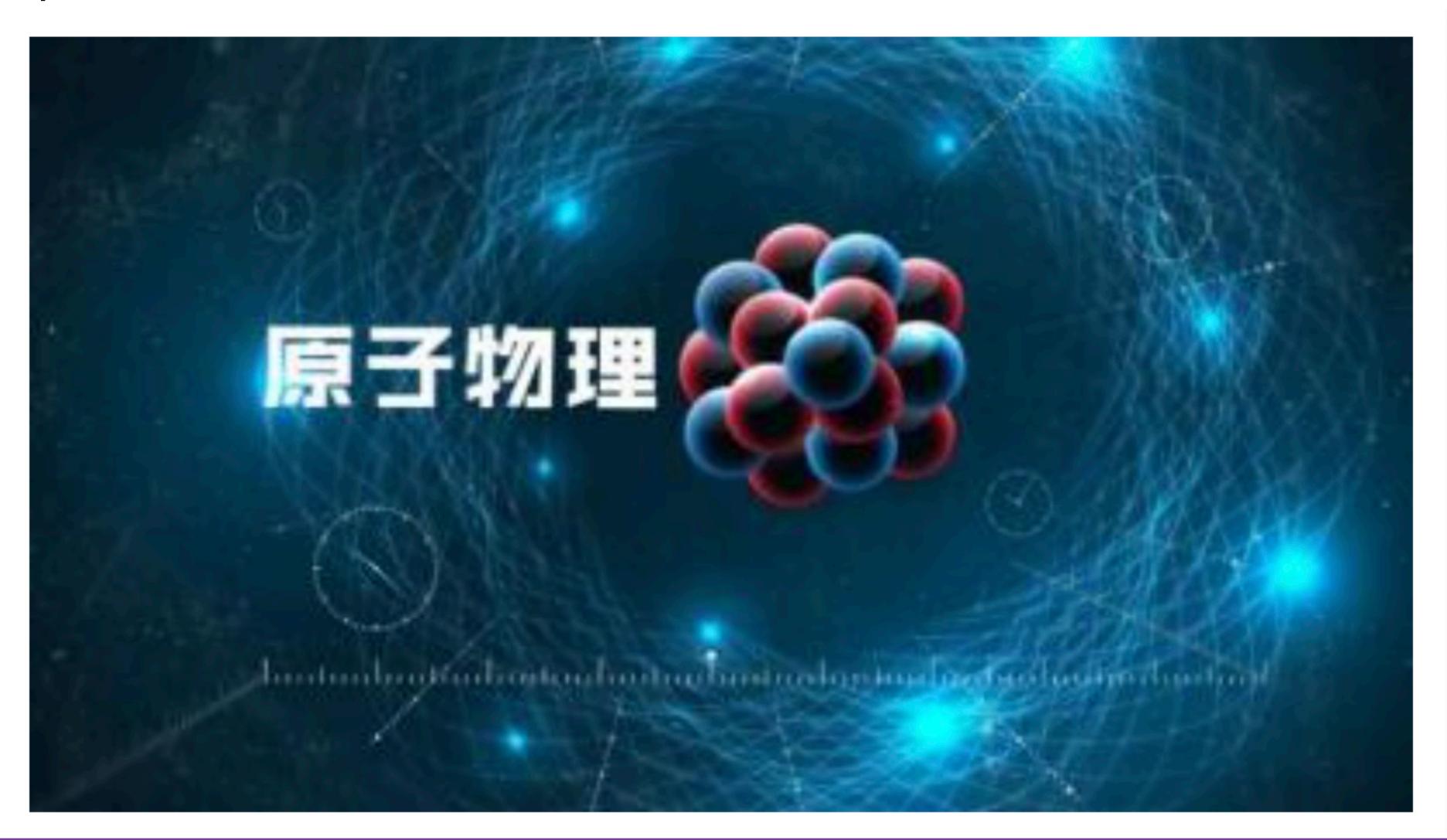




Class requirements



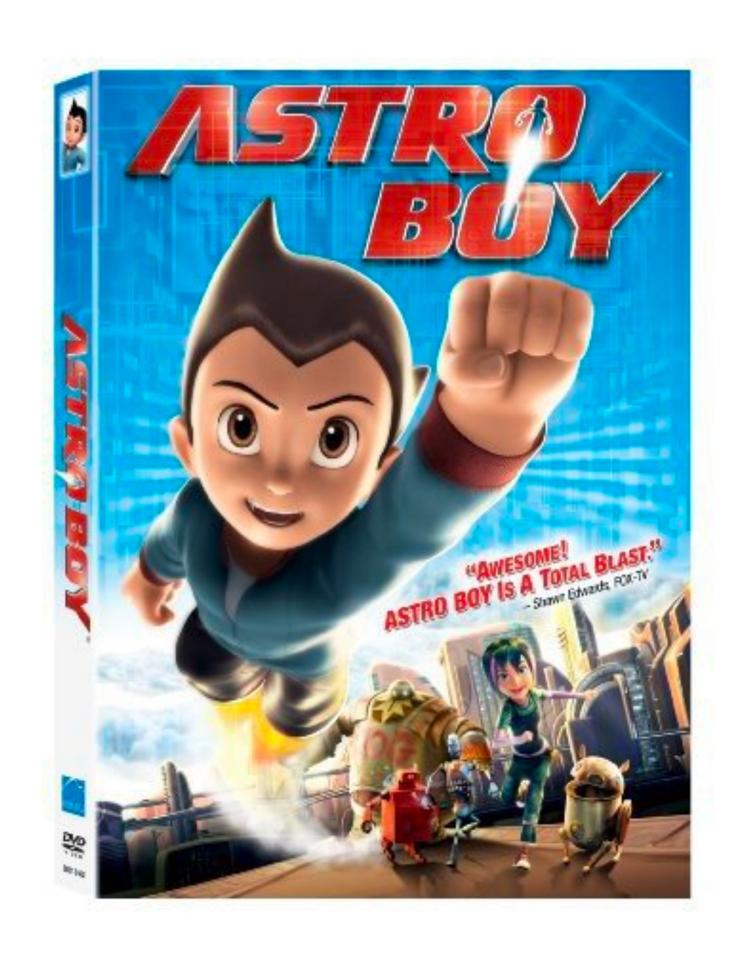
http://coursehome.zhihuishu.com/courseHome/1000008969#teachTeam



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The movie of Astro boy



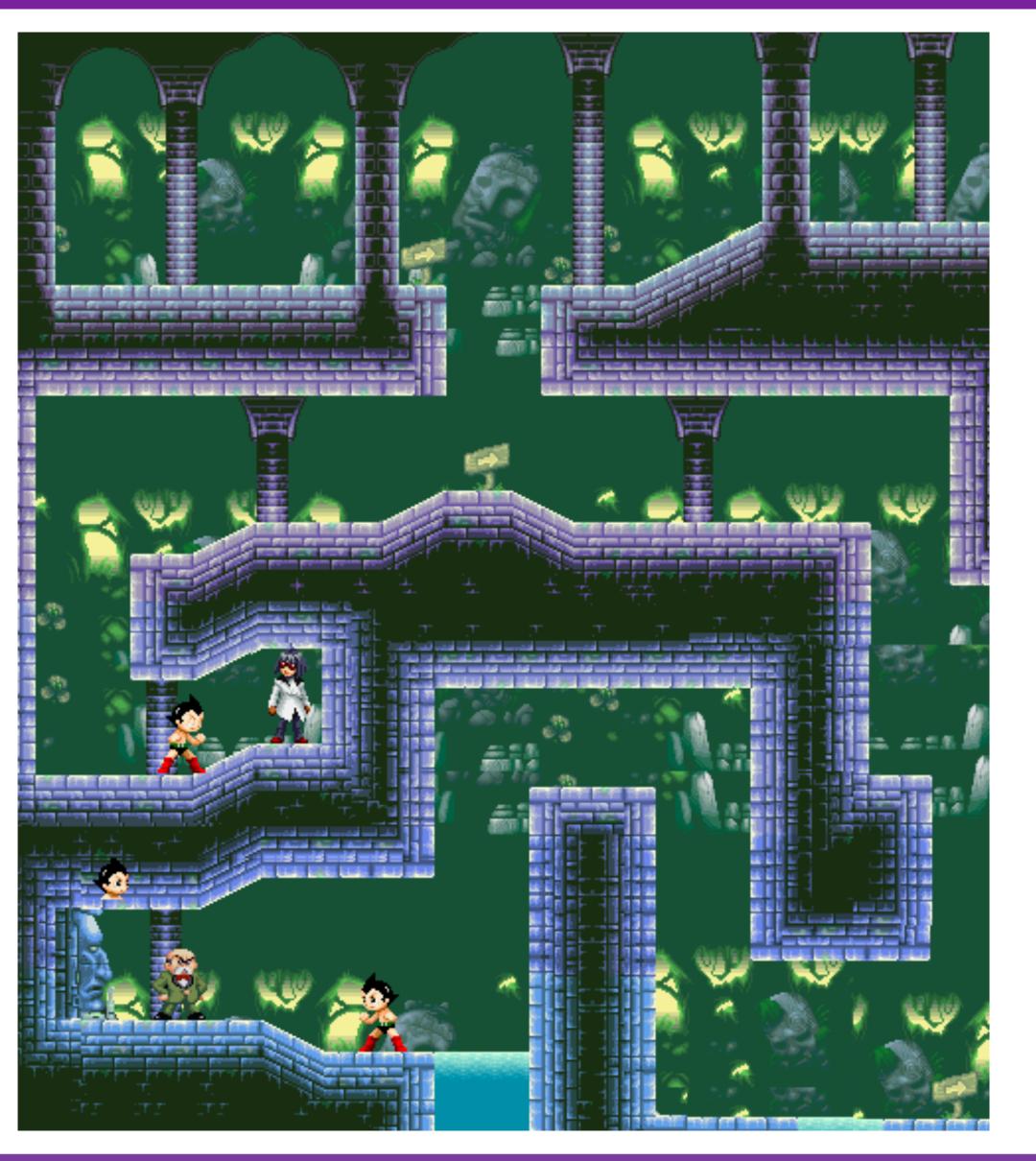




The game of Astro boy

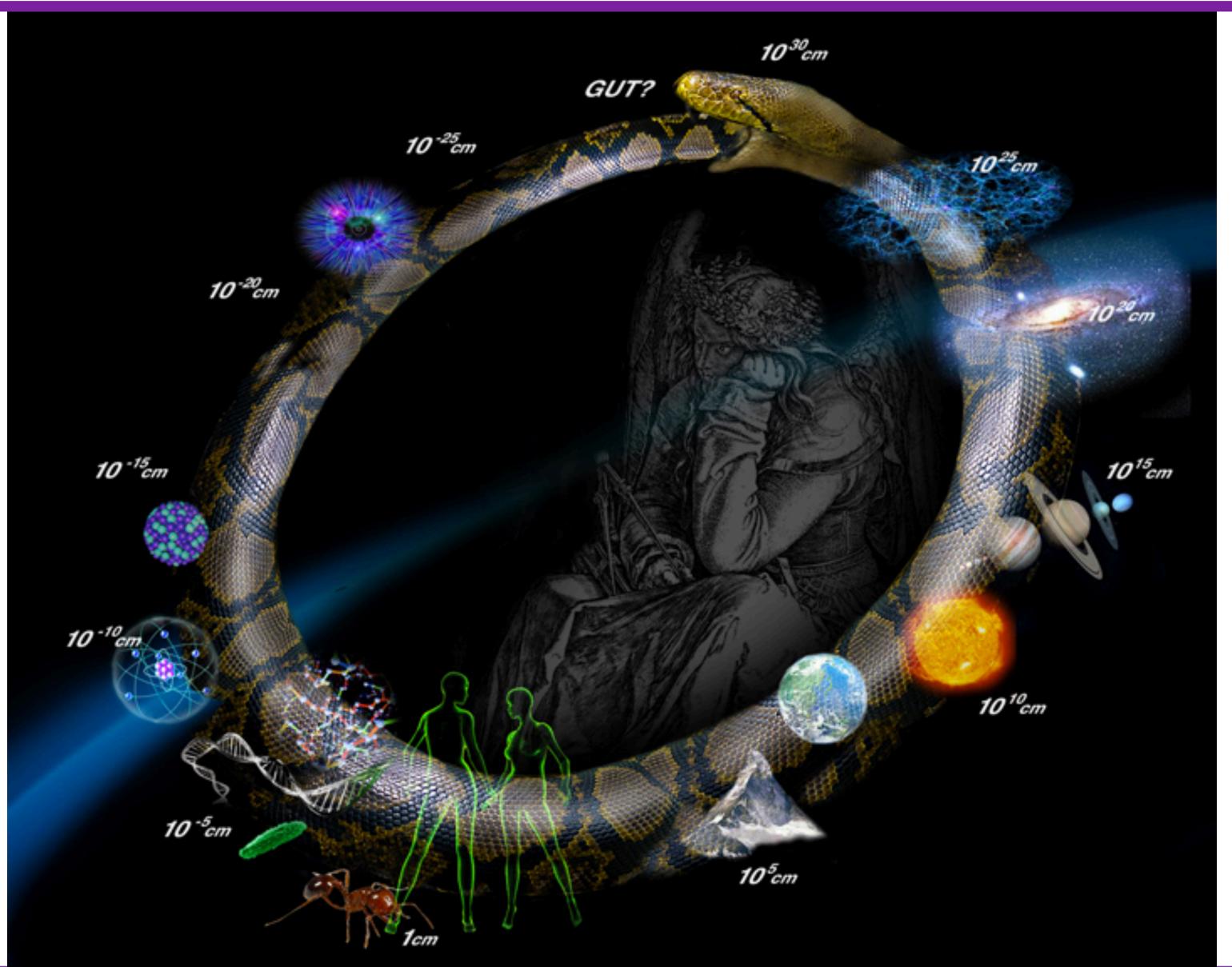






Cosmic Uroboros

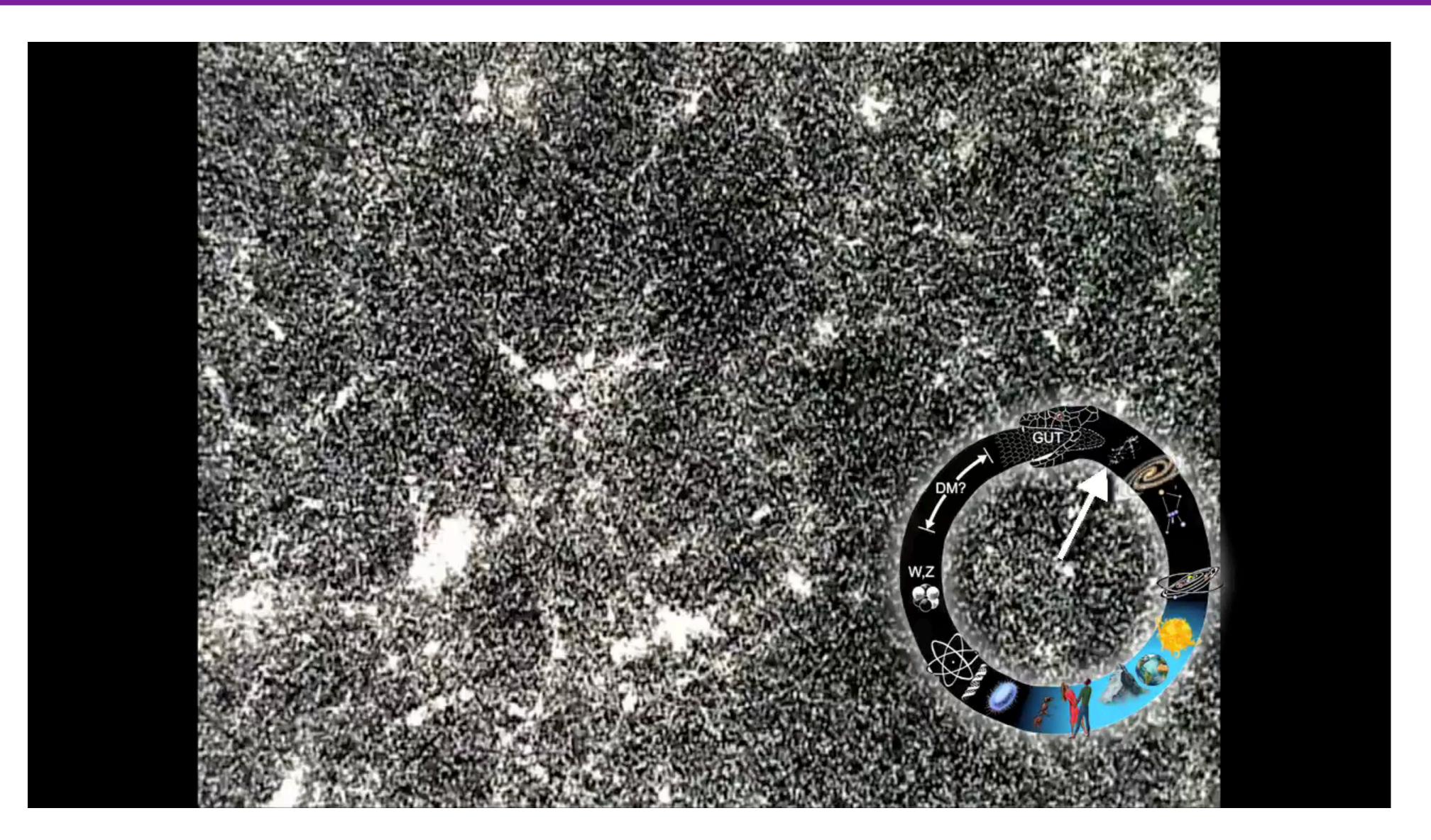




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Cosmic Uroboros

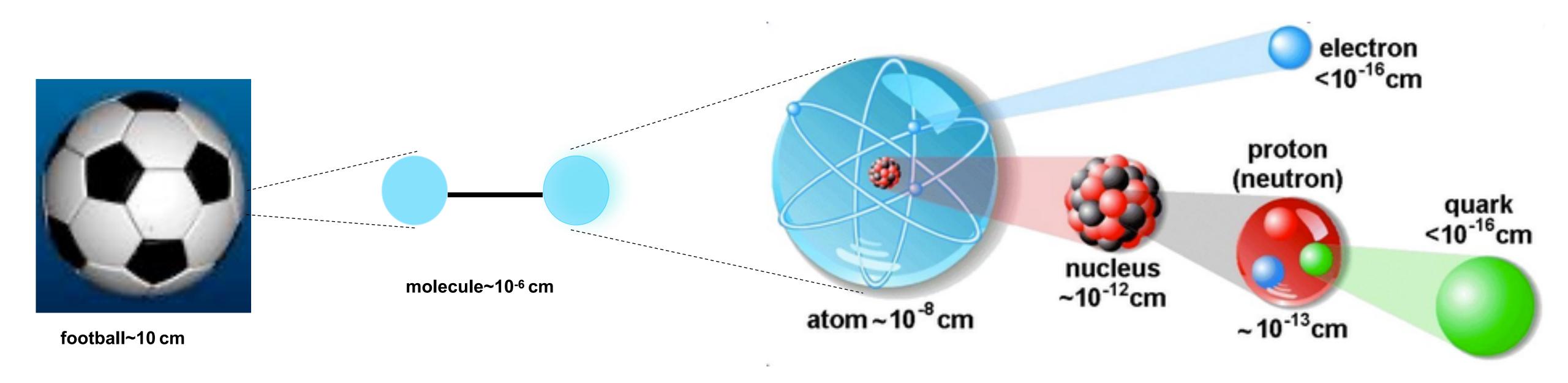




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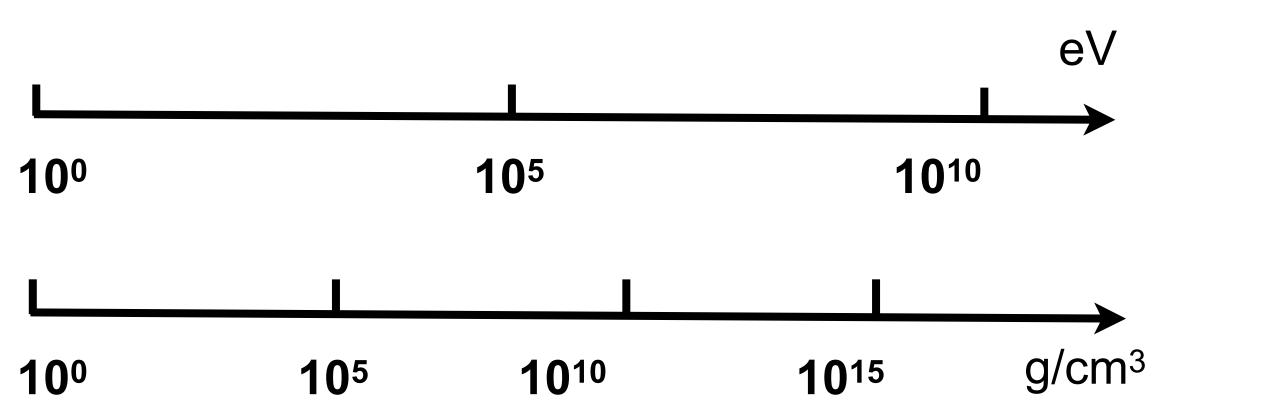
Atom size





Range of excitation energies

Range of densities



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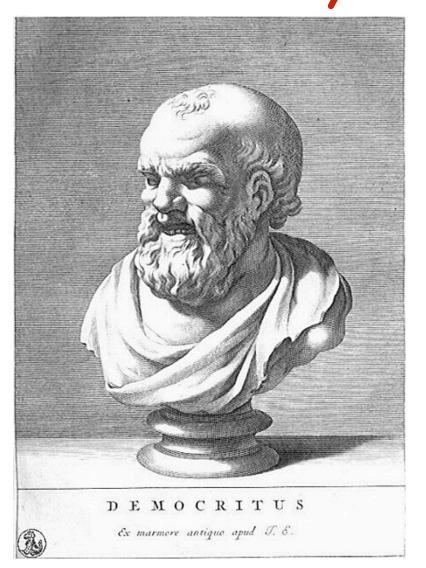
The ancient atomic theories

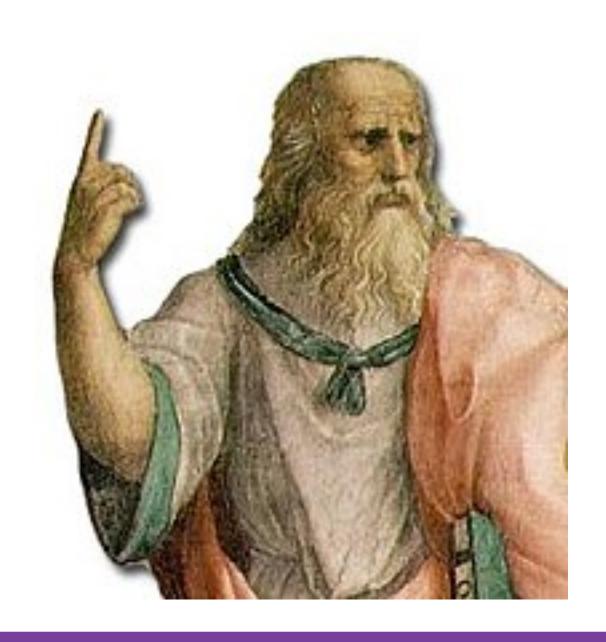


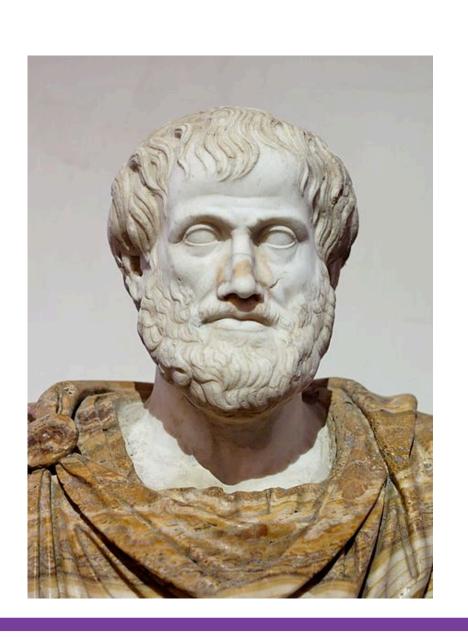
✓ Atom comes from the Greek and means "the indivisible", the smallest component of matter, which cannot be further divided.

√The first atomic theories of the structure of matter were those of Democrites (460 - 370 B.C.), Plato (427 - 347 B.C.), and Aristotle (384-322 B.C.).

Democracy







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The ancient atomic theories



√"端:体之无序最前者也"

《墨经》

√"语小,天下莫能破焉"。

《中庸》

√"一尺之槌, 日取其半, 万世不竭"

《庄子·天下篇》

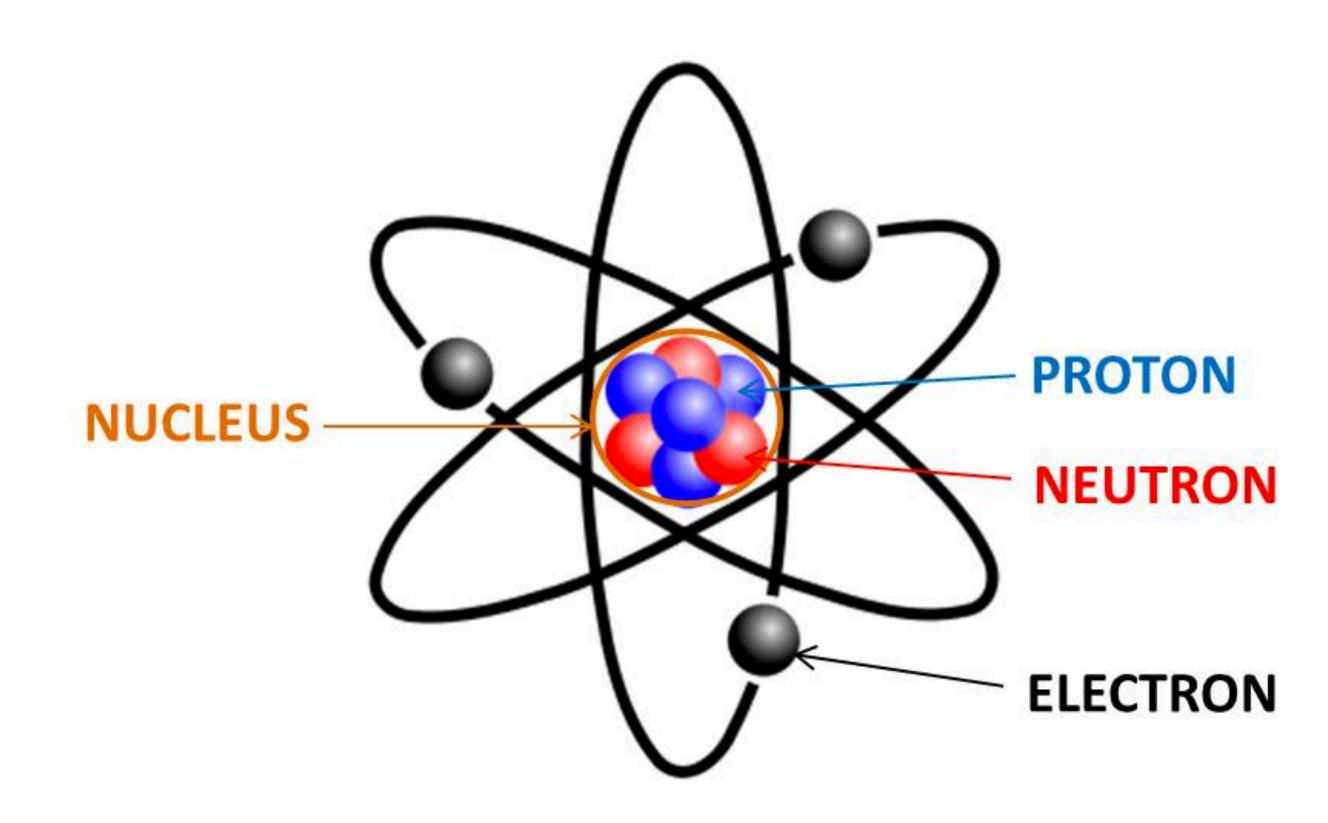




Short Historical Review



 \checkmark The meaning of the word "atom" becomes less subject to misinterpretation if it is translated into Latin: an individuum (不可分) is the smallest unit of large set which possesses all the essential characteristics of the set.



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- ✓ All the chemical elements are composed of atoms were recognized from chemical investigations.
- √ The laws of constant and multiple proportions:

 (J. L. Proust and Dalton)

 In a mixture of non-reacting cases, the total pressure exerted is
 - In a mixture of non-reacting gases, the total pressure exerted is equal to the sum of the partial pressures of the individual gases. (在组分之间不发生化学反应的前提下,理想气体混合物的压强等于各组分的分压之总和)
- √1815 The first atomic model (W. Prout):

 The atoms of all elements are put together out of hydrogen atoms.

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- ✓ Matter is made up of atoms that are indivisible and indestructible.
- √All atoms of an element are identical.
- √Atoms of different elements have different weights and different chemical properties.
- √Atoms of different elements combine in simple whole numbers to form compounds.
- √Atoms cannot be created or destroyed. When a compound decomposes, the atoms are recovered unchanged.

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√1808 The volume of gaseous reactants occur as ratios of small integers (Gay-Lussac)

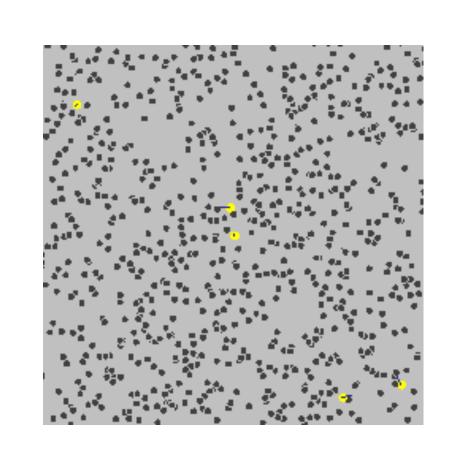
(在同温同压下,气体相互之间按照简单体积比例进行反应,

并且生成的任一气体产物也与反应气体的体积成简单整数比)

- √1811 Hypothesis of Avogadro: Equal volumes of gases under similar conditions contain equal numbers of molecules.
- √1826 Brown motion:

The random motion of particlessuspended in a fluid (a liquid or a gas) resulting from their collision with the fast-moving atoms or molecules in the gas or liquid.





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√ 1833, Faraday laws:

- 1. The quantity of an element which is separated is proportional to the quantity of charge transported in the process.
- 2. Various elements are separated into equivalent weights by the same quantity of charge.
 - 1. 物质在电解过程中,参与电极反应的质量与通过电极的电量成正比。
- 2. 不同物质电解的质量则正比于该物质的化学当量。

Periodic table



√ 1869, Periodic table (L. Meyer and D. I. Mendeleev)



опыть системы элементовъ,

основанной на ихъ атомномъ въсъ и химическомъ сходствъ.

			Ti=50	Zr=90	?=180.
			V=51	Nb=94	Ta=182.
			Cr=52	Mo=96	W=186.
			Mn=55	Rh=104,4	Pt=197,1.
			Fe=56	Ru=104,4	Ir=198.
		Ni	=Co=59	Pd=106,6	Os=199.
H=1			Cu=63,4	Ag=108	Hg=200.
	Be= 9,4	Mg=24	Zn=65,2	Cd=112	
	B=11	A1=27,3	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210?
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	I=127	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204.
		Ca=40	Sr=87,6	Ba=137	Pb=207.
		?=45	Ce=92		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?	•	

Д. Менделѣевъ

Periodic table



√ 1869, Periodic table (L. Meyer and D. I. Mendeleev)

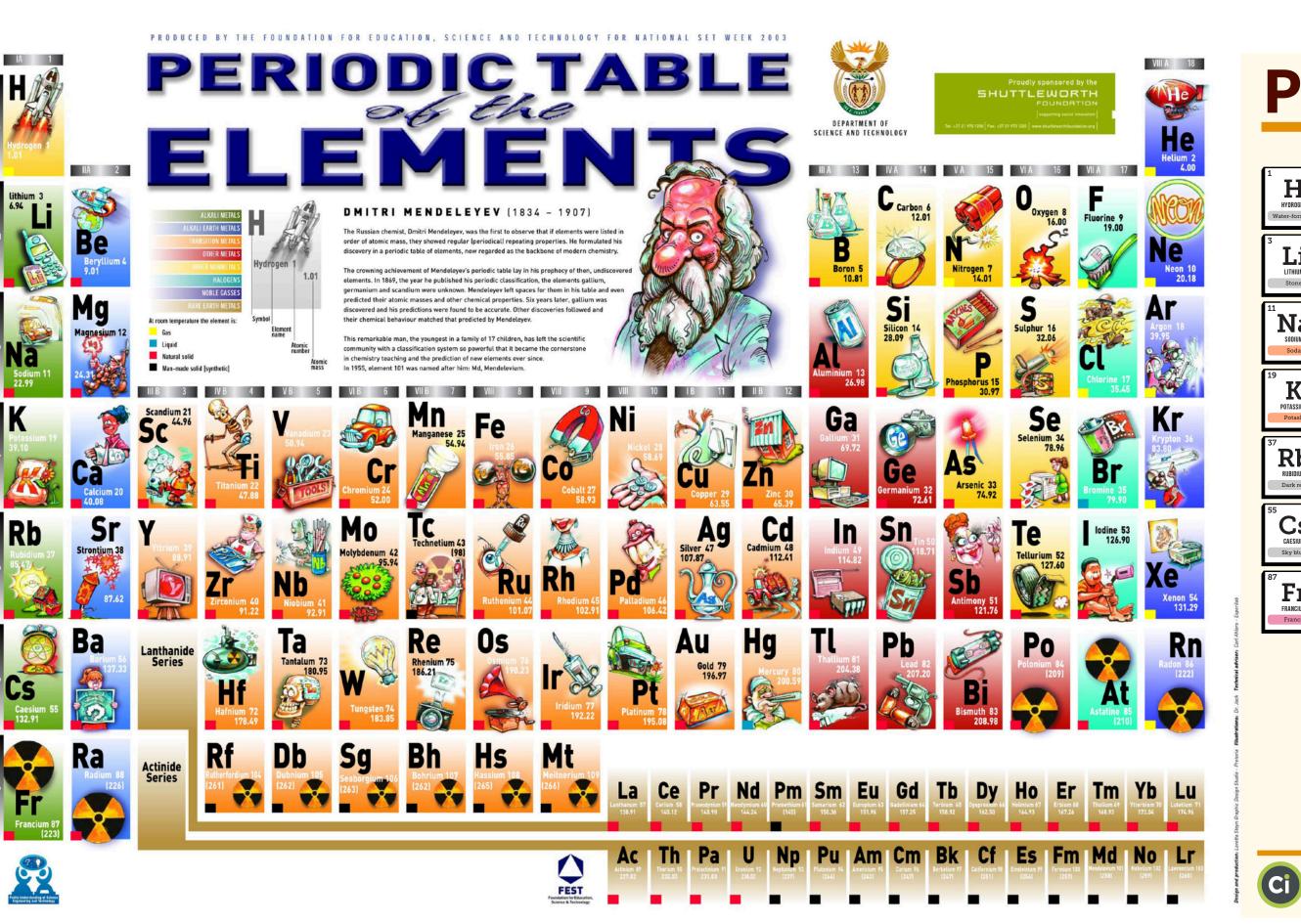


					Li=7							H=1						
					Na=23	F=19	0=16	N=14	C=12	B=11	Be= 9,4							
?In=75,6	?Yt=60	?Er=56	?=45	Ca=40	K=39	Cl=35,5	S=32	P=31	Si=28	Al=27,3	Be= 9,4 Mg=24		Ni					
Th=118?	Di=95	La=94	Ce=92	Sr=87,6	Rb=85,4	Br=80	Se=79,4	As=75	?=70		Zn=65,2	Cu=63,4	Ni=Co=59	Fe=56	Mn=55	Cr=52	V=51	Ti=50
				Ba=137	Cs=133	I=127	Te=128?	Sb=122	Sn=118	Ur=116	Cd=112	Ag=108	Pd=106,6	Ru=104,4	Rh=104,4	Mo=96	Nb=94	Zr=90
				Pb=207.	T1=204.			Bi=210?		Au=197?		Hg=200.	Os=199.	Ir=198.	Pt=197,1.	W=186.	Ta=182.	?=180.

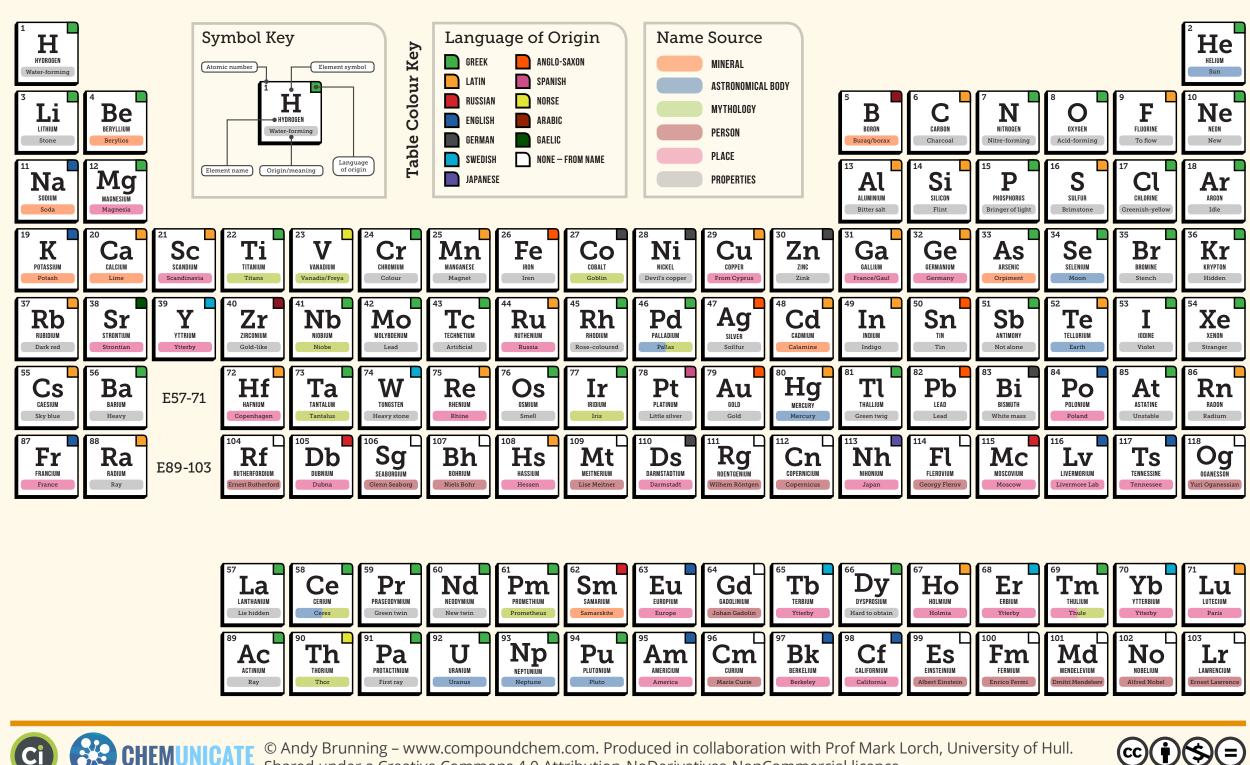
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Periodic table





PERIODIC TABLE: ELEMENT NAME ORIGINS



Modern atomic physics



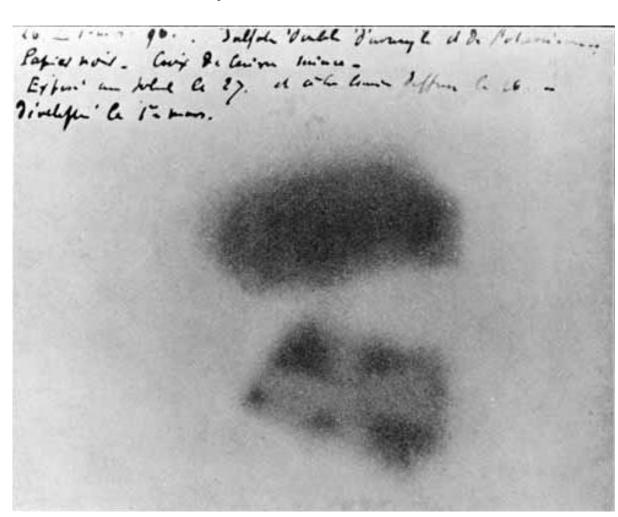
√ 1885, Ordering principle in atomic spectra (J. Balmer)

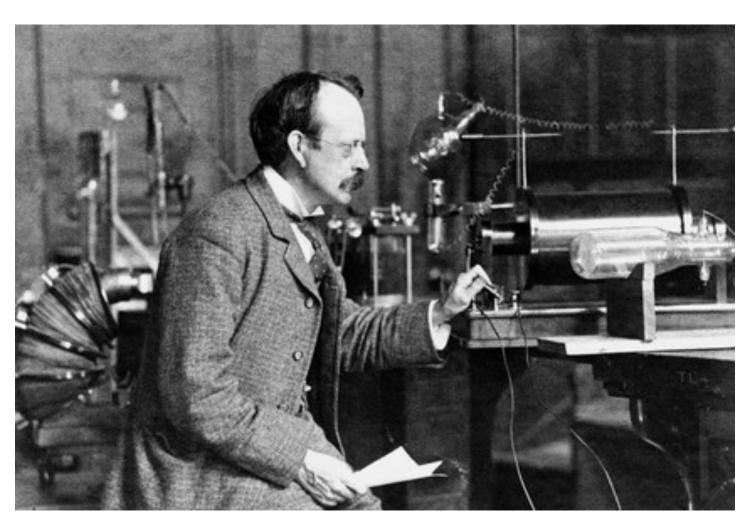
√ 1895, X ray (W. Roentgen)

√ 1896, Radiation (A. H. Becquerel)

√ 1897, The discovery of electron (J. J. Thomson)







Modern atomic physics



- √ 1885, Ordering principle in atomic spectra (J. Balmer)
- √ 1900, The laws of black body radiation (M. Plank)
- √ 1911, Planetary model of the atom (E. Rutherford)
- √ 1913, Bohr model for hydrogen
- √ 1925, Matter waves (De Broglie)
- √ 1926, Schroedinger equation (E. Schroedinger)
- √ 1928, Dirac equation (P. Dirac)

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Modern atomic physics



Fifth Solvay conference 1927

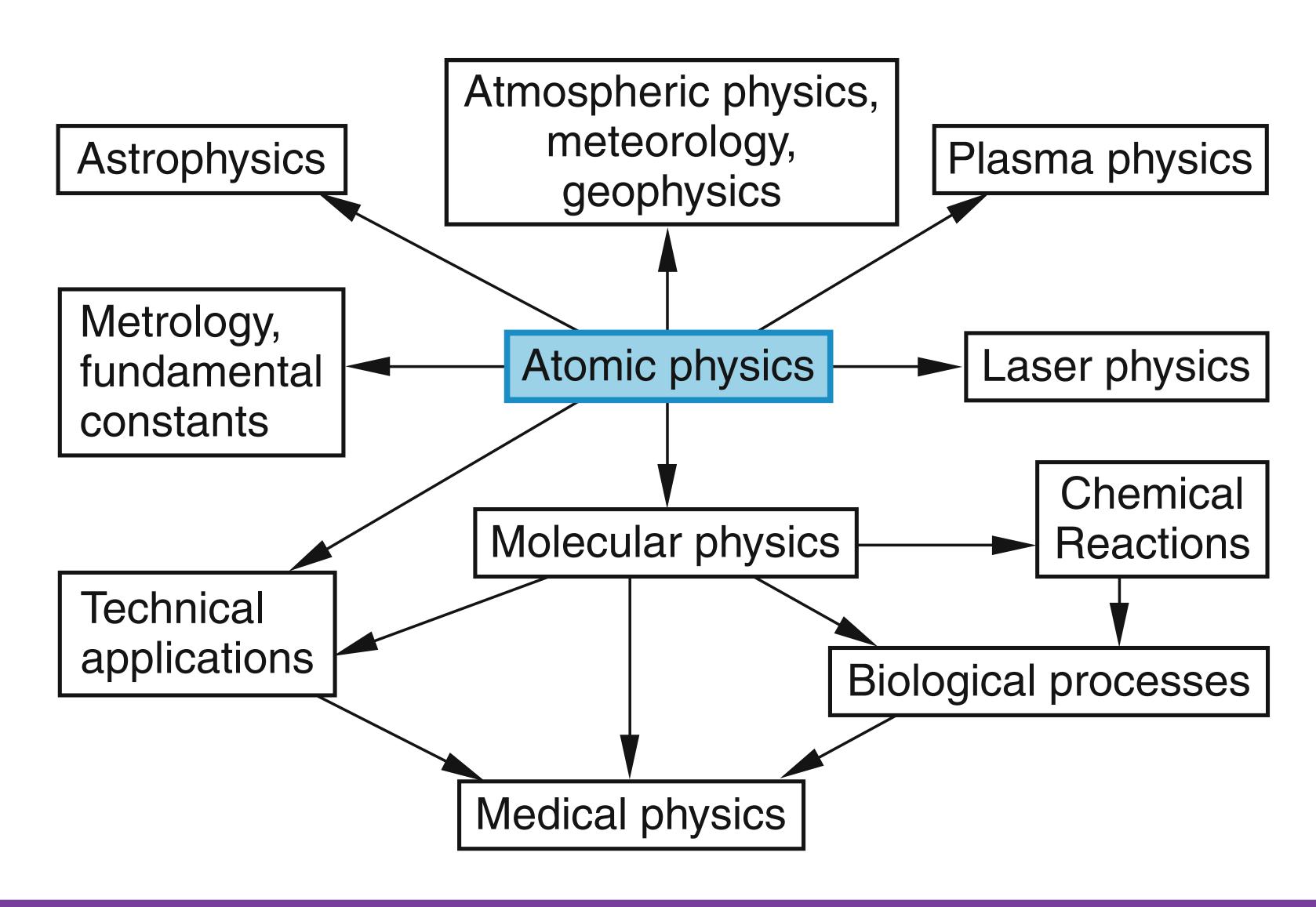


17 Nobel Prize winners! Niubility!

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The central role of atomic physics

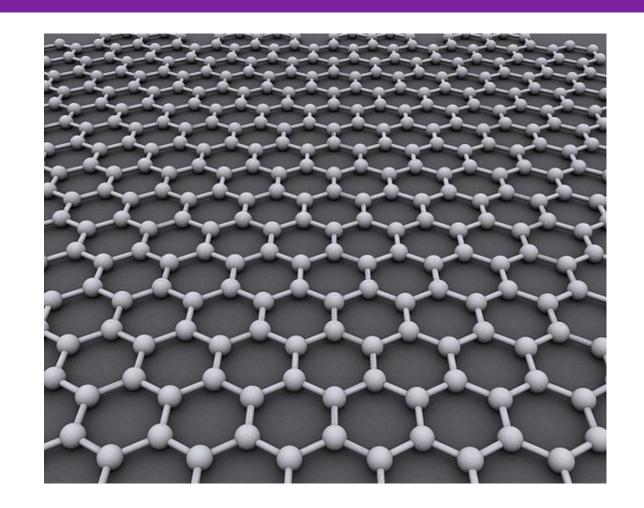




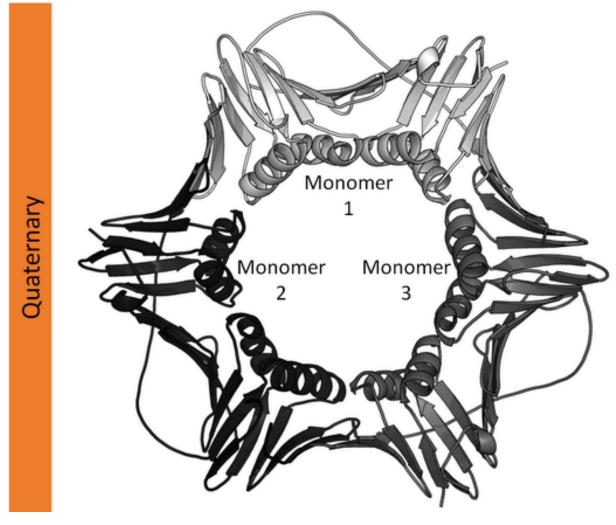
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The application of atomic physics

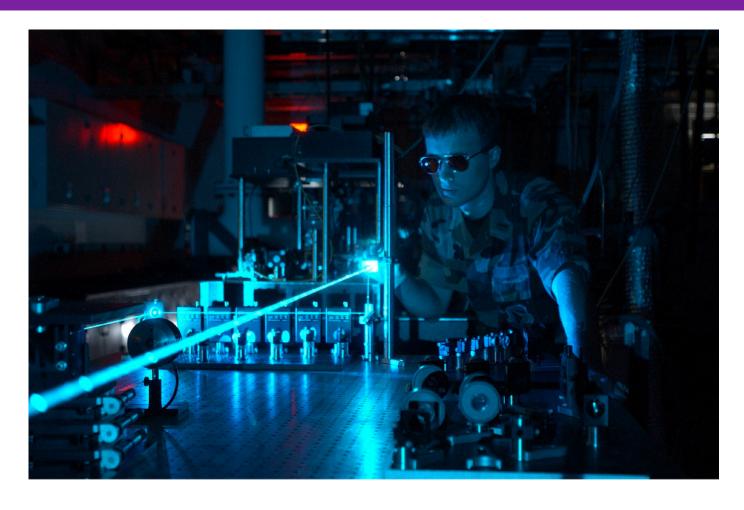




Graphene



Biomolecular structure



Laser

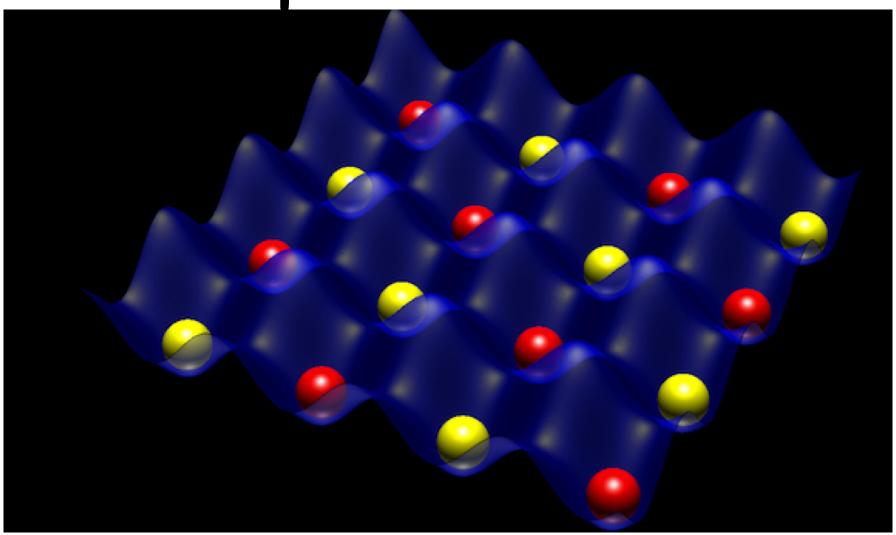


CT Scan

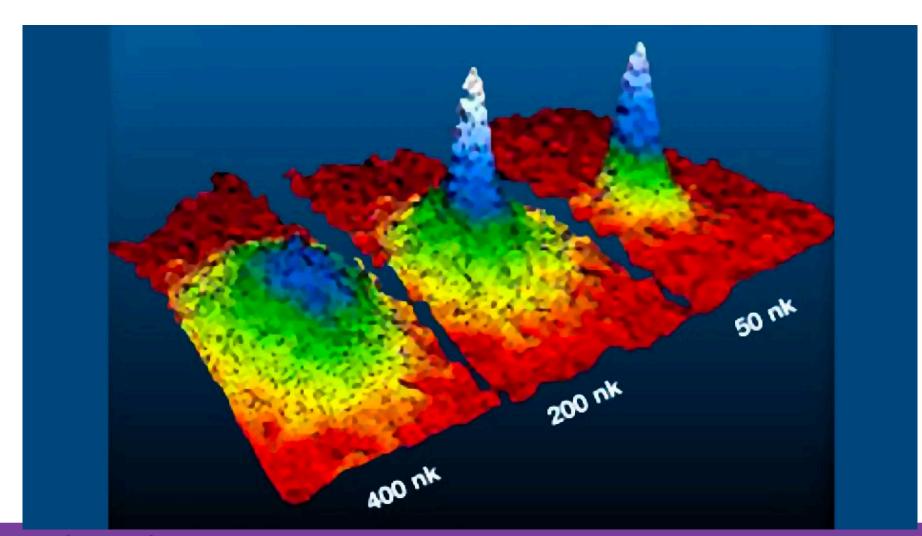
The application of atomic physics



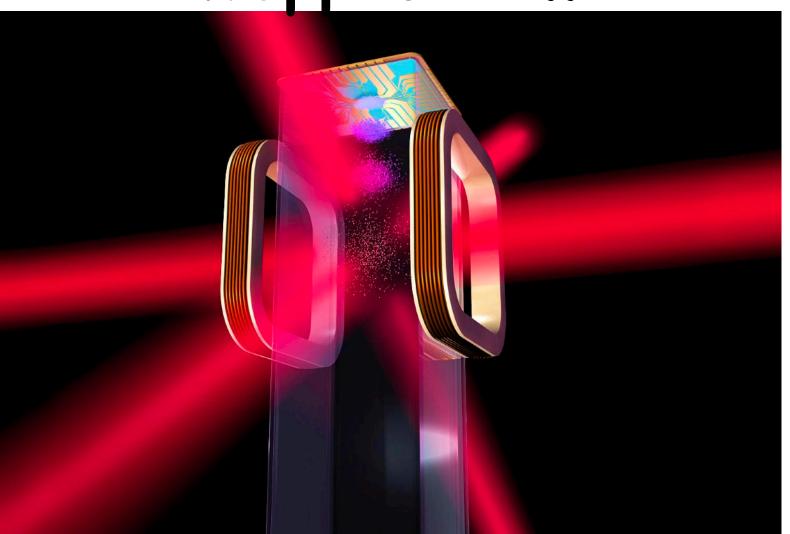
Optical lattice



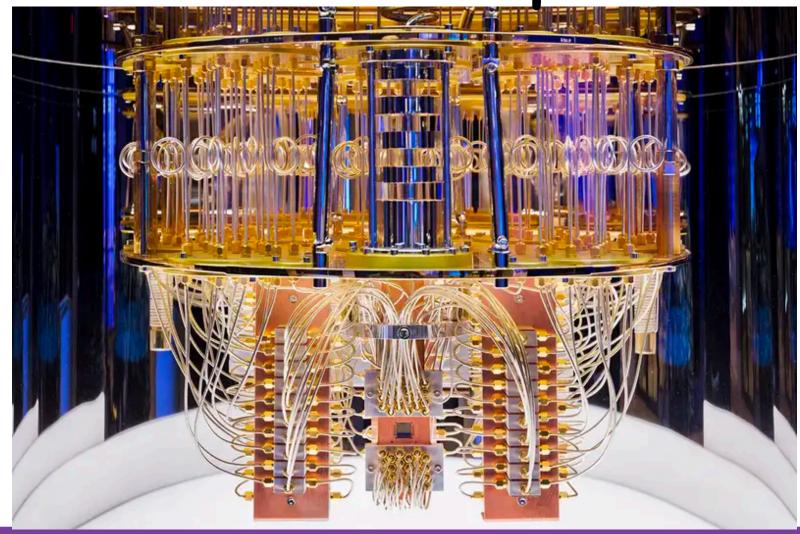
BEC condensation



Trapped well



Quantum computer



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Class outline



√ Introduction (2 classes)

√ Basic Properties of Atom (4 classes)

√ Bohr's Model of the Hydrogen Atom (6 classes)

√ Quantum Mechanics of the Hydrogen Atom (8 classes)

√ Fine structures of Atoms (8 classes)

√ Many-Electron Atoms (8 classes)

√ X-Ray (8 classes)

√Nuclear physics (4 classes)

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