Light 光

History of trying to understand reality by studying light.
在历史上试图通过光学来理解现实

The history of light: the spectrum https://www.youtube.com/watch?v=QSF_jiy5Ug4
光的历史：光谱 https://www.youtube.com/watch?v=QSF_jiy5Ug4
The history of light: waves and photons https://www.youtube.com/watch?v=OLCqaWaV6jA
光的历史：波和光子 https://www.youtube.com/watch?v=OLCqaWaV6jA
Wave-Particle Duality of Light https://www.youtube.com/watch?v=h1tflE-L2Dc
光的波粒二象性 https://www.youtube.com/watch?v=h1tflE-L2Dc

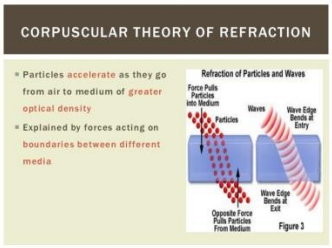
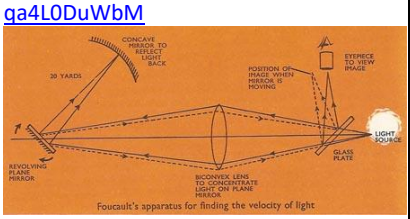
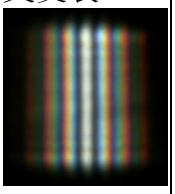
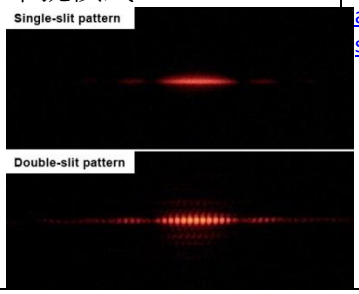
Quantum Fields The Real Building Blocks of the Universe - with David Tong 2017
量子场是宇宙的真正积木- David Tong 2017
https://www.youtube.com/watch?v=zNVQfWC_evg

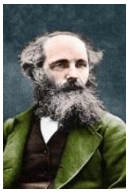
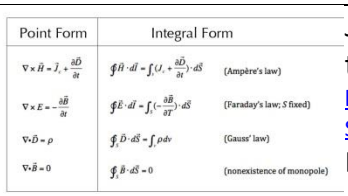
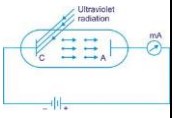
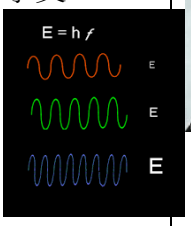
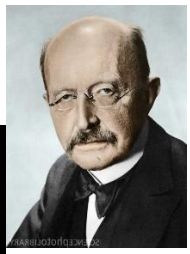
Lesson: The word light is misleading; we think only of the visible spectrum. In physics, “light” refers to the entire electromagnetic spectrum from radio waves to gamma ray
经验总结：“光”一词误导我们仅想到可见光谱。在物理学上，“光”是指从无线电波到伽马射线的整个电磁波谱。

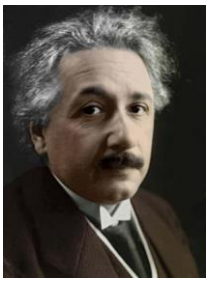
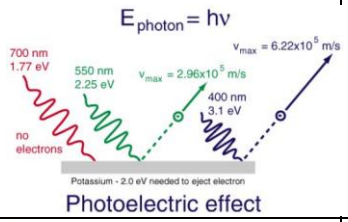
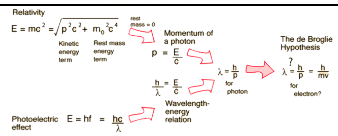
The following summary table provide background knowledge necessary to begin learning about light being the secret to unlocking the workings of our universe (dharma, uphold) e.g. why is light “speed” a universal constant.
下表总结了理解光所需要的背景知识，帮助我们学习如实正观，打开宇宙运作的秘密（微妙法）等。比如说为什么光速是宇宙常数？

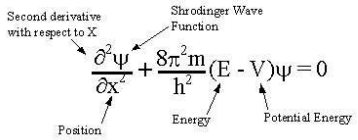
Milestones in understanding the nature of light
光本质研究的里程碑

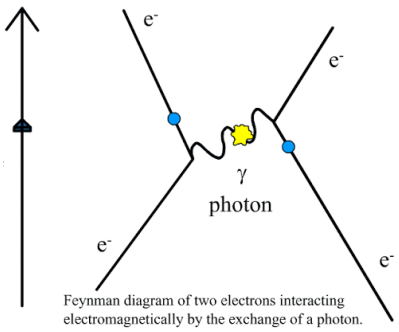
Year of Publication 发表年份	Physicist 物理学家	Light is 光是	Evidence 证据	Source 来源

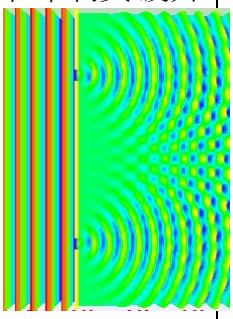
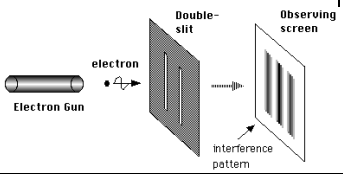
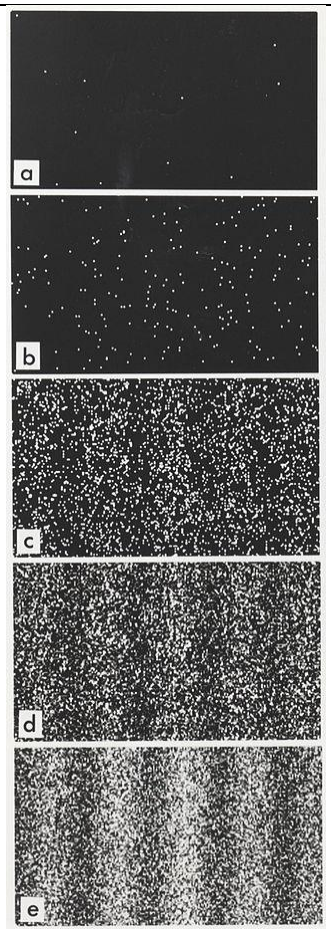
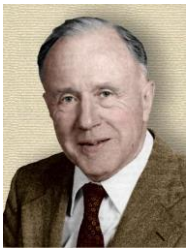
1672 lecture 1675 book “Opticks” described “Corpuscular theory of light”. 1672 年讲座 1675 年在“光学”一书中描述“光的微粒理论”。	Sir Isaac Newton British 艾萨克·牛顿爵士 英国人 	Particle 微粒	Prism. Diffraction means light is faster in water than in air. 棱镜。衍射意味着光在水中比在空气中快。 	Newton's Corpuscular Theory https://www.youtube.com/watch?v=9vQIrHJ6MY8 PDF www.thestargarden.co.uk/Newtons-theory-of-light.html PDF http://galileo.phys.virginia.edu/classes/609.ral5q.fall04/LecturePDF/L20-LIGHTII.pdf
1678	Christiaan Huygens Dutch 克里斯蒂安·惠更斯 荷兰人 	Waves 波动	1850 Foucault & Fizeau invention showed light is slower in water than in air 1850 年福柯和斐索发明的仪器显示：光在水中比在空气中要慢。	Huygens' Principle https://www.youtube.com/watch?v=vqa4L0DuWbM 
1803 lecture 1804 paper published 1803 年讲座 1804 年论文发表 	Thomas Young British 托马斯.杨 英国人 	Waves 波动	Double slit experiment showed light interfere with itself exhibiting interference pattern typical of waves 双缝实验表明光干涉本身表现出典型的波干扰模式 	Thomas Young-Original Double Slit Experiment https://www.youtube.com/watch?v=Iuv6hY6zsd0 MIT Thomas Young's double slit https://www.youtube.com/watch?v=CN-wjj_phVA Animation url https://commons.wikimedia.org/wiki/Category:Animations_of_double-slit_experiments

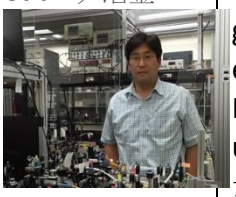
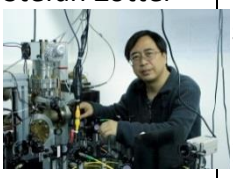
1865 	James Maxwell Scottish 詹姆斯.麦克斯韦 苏格兰人 Thought experiment combining Gauss's law, Faraday's law and Ampere's law. 结合高斯定律、法拉第定律和安培定律的思维实验	Electro magnetic radiation 电磁波	 Hertz 1886 confirm experimentally by inventing a nanosecond on-off switch 赫兹 1886 年通过发明纳秒开关来确认实验	James Clerk Maxwell - What's the go o' that? https://www.youtube.com/watch?v=44SI1D5UGrg Electromagnetism in five minutes (Maxwell) https://www.youtube.com/watch?v=GKGd5RBfdDY
1885  	Heinrich Hertz German 海因里希.赫兹 德国人 	Photoelectric effect 光电效应	UV hits micro plague emits electricity but red light does not 紫外线击中导电板会发射电力，但红光线不会	Electromagnetic Wave-Heinrich Hertz's Experiment https://www.youtube.com/watch?v=QZXYFr5YHew Hertz (homemade) Experiment on Electromagnetic Waves https://www.youtube.com/watch?v=9gDFll6Ge7g
Nobel Prize in Physics in 1918 1918 年诺贝尔物理学奖  	Max Planck 普朗克 德国人 German 	Quantum = Energy packet = E = hv h= Planck's constant 量子 = 能量包 = E = hv h=普朗克常数	Planck's constant links the amount of energy a photon carries with the frequency of its electromagnetic wave. **Planck Constant** = $6.62607004 \times 10^{-34}$ m^2 kg / s (or joule second) **Planck length** 1.6 x 10^{-35} m (10^{-20} times the size of a proton) is the smallest measurement of **length** with any meaning. 普朗克常数把光子的能量与电磁波的频率	Wikipedia - discovery of quantum leap https://simple.wikipedia.org/wiki/Planck_constant #3 Max Planck ~ Quantum Physics https://www.youtube.com/watch?v=Ex8EvBTk9LY **Planck time** (t_P) is the unit of **time**， is the time required for light to travel, in a vacuum, a distance of 1 **Planck** length, approximately 5.39×10^{-44} s. 普朗克时间 (t_P) 是时间的单位，是光旅行所需的时间, 在真空中, 一个普朗克长度的距离, 约 5.39 x 10^{-44} s。

			联系在一起。普朗克常数= $6.62607004 \times 10^{-34}$ 平方米千克/秒（或焦耳秒） 普朗克长度 1.6×10^{-35} 米（质子大小的 10^{-20} 倍）是可测量的有意义的最小长度。	
1905 linking the Planck constant to photoelectric effect ; 1921 Nobel Prize for Photoelectric effect 1905 年 联系普朗克常数和光电效应 1921 年诺贝尔奖 光电效应	Albert Einstein Born in Germany 阿尔伯特爱因斯坦 出生于德国 	Named light quantum as photon 命名光量子为光子	Photoelectric effect: beam of light is not a wave propagating through space but rather a collection of discrete wave packets (photons), each with energy. 光电效应：光束不是通过空间传播的波，而是离散波包（光子）的集合，每一个都带有能量。 	#3 Max Planck ~ Quantum Physics https://www.youtube.com/watch?v=Ex8EvBTk9LY 9:04 Wave-Particle Duality and the Photoelectric Effect – Prof Dave https://www.youtube.com/watch?v=MFPKwu5vugg #4 The Origin of Quantum Mechanics (feat. Neil Turok) https://www.youtube.com/watch?v=i1TVZIBj7UA
1924 1929 Nobel Prize 1924 1929 年诺贝尔奖	Loiuise de Brogli French 路易斯.布罗意 法国人 	Wave-particle duality 波粒二象性		A Level Physics - The de Broglie Wavelength and Wave Particle Duality https://www.youtube.com/watch?v=ZqspDsQSZuI Matter as a Wave https://www.youtube.com/watch?v=caVIh3RZOA4
1925 1932 Nobel Prize	Werner Heisenberg German	Wave Function And	Uncertainty Principle: knowledge on location (at the single slit) and	What is the Uncertainty Principle?

诺贝尔奖	沃纳·海森堡 德国人 	Wave-Particle Duality 波的功能和波粒二象性	momentum (destination) are inversely related. Nature does not allow knowing both position & momentum. https://www.youtube.com/watch?v=7GTCus7KTb0 不确定性原理：位置（单缝）和动量（目的地）的知识是负相关的。“大自然”不允许同时知道位置和动量。 https://www.youtube.com/watch?v=7GTCus7KTb0	https://www.youtube.com/watch?v=7vc-Uvp3vwg Heisenberg Uncertainty Principle Party Trick https://www.youtube.com/watch?v=IS9qAUcoWG8 Heisenberg's Uncertainty Principle Explained https://www.youtube.com/watch?v=a8FTr2qMutA
1925; 1933 Nobel Prize 诺贝尔奖 	Erwin Schrödinger Austrian 埃尔温·薛定谔 奥地利人	Probability wave equation 光波波动方程	Building on Louis de Broglie's hypothesis of "electron waves" Schrödinger develops a wave equation for electrons. 基于布罗意的“电子波”假想，薛定谔发展出光波波动方程。	Schrodinger's Equation https://www.youtube.com/watch?v=jvvkomcmyuo 
1926 paper 1954 Nobel Prize 1926 论文 1954 诺贝尔奖	Max Born German 马克思.玻恩 德国人 	Probability waves 概率光波	First to interpret Schrödinger's wave function as probability amplitude. He proved Schrödinger's wave equation could be interpreted as giving statistical (rather than exact) predictions of variables. 首次解释了薛定谔的波函数原来是概率振幅。他证明了薛定谔波动方程可以解释变量的统计（而不是精确的）预测。	PDF http://physics.mq.edu.au/~jcresser/Phys201/LectureNotes/TwoSlitExpt.pdf https://www.nobelprize.org/nobel_prizes/physics/laureates/1954/born-facts.html

1948 Feynman diagrams represent math expressions describing behavior of subatomic particles. 1965 Nobel Prize 1948 费曼图表示描述亚原子粒子行为的数学表达式 1965 年诺贝尔奖	Richard Feynman American 理查德.费曼 美国人 		Thought experiment that if detectors were placed before each slit, the interference pattern would disappear.[17] 假想实验，如果探测器被放置在每个狭缝，干涉图样会消失。	http://www.vivaxsolutions.com/physics/feynman-diagrams.aspx  Feynman diagram of two electrons interacting electromagnetically by the exchange of a photon. Awesome Homemade Quantum Eraser experiment 自制“延迟选择擦掉量子位置信息”实验 https://www.youtube.com/watch?v=R-6St1rDbzo

1974 *American Journal of Physics 1974 年美国物理期刊*	Italian physicists 意大利物理学家  Pier Giorgio Merli，Gianfranco Missiroli, and Giulio Pozzi 比尔·乔治·梅林，奇安弗兰科·米西罗利，和朱利奥·波齐 	Electrons behave same as photons 电子和光子一样反应	Repeated double-slit experiment using single electrons and biprism (instead of slits), showing that each electron interferes with itself as predicted by quantum theory. 使用单电子和双棱镜（非狭缝）重复双缝实验，表明量子理论所预测的每个电子本身自动干扰。 Single electrons hit screen as particles accumulate to wave interference pattern 单电子击中屏幕粒子累积到波干扰模式 http://l-esperimento-piu-bello-della-fisica.bo.imm.cnr.it/english/themovie.html 	
1978 “Delayed Choice Eraser” double slit thought experiment 1978 年“延迟选择擦掉量子位置信息”双缝假想实验	John Wheeler American 约翰·惠勒美国人  Feynman’s prof 费曼的教授	Observer determine the past 观察者决定过去（倒果为因）	1979 U Maryland lecture https://www.anthonypeake.com/627/ at the last possible sec the experimenter can choose to remove the photographic plate, revealing, e.g, two small telescopes: one pointed at the left slit, the other at the right. 1979 年马里兰大学讲座 https://www.anthonypeake.com/627/	Delayed choice quantum eraser https://en.wikipedia.org/wiki/Delayed_choice_quantum_eraser#The_experiment_of_Kim_et_al._.282000.29 Double slit experiment [NOVA] Brian Green https://www.youtube.com/watch?v=M4_0oblwQ_U

			在最后关头，实验者可以选择移除摄影板，板后显示例如两个小望远镜：一个指向左边的狭缝，另一个指向右边。	
1999 did the “Delayed Choice Eraser” double slit experiment 1999 年实践“延迟选择擦掉量子位置信息”双缝实验	Yoon-Ho Kim et al. 尹浩金 	quantumentanglement explains Retrocausality 量子纠缠是因果同时的原理，不需要引用倒果为因。	Delayed Choice Quantum Eraser 延迟选择擦掉量子位置信息 https://www.youtube.com/watch?v=u9bXolOFAB8 Delayed Choice Quantum Eraser Experiment Explained 延迟选择擦掉量子位置信息试验解释 https://www.youtube.com/watch?v=H6HLjpj4Nt4	Quantum Eraser (Time - History Rewrite) / Delayed Choice Experiment - Better than Double Slit https://www.youtube.com/watch?v=KnpCH9VRvPg How the Quantum Eraser Rewrites the Past | Space Time | PBS Digital Studios https://www.youtube.com/watch?v=8ORLN_KwAgs
2012 *Nature Physics 8, 480-489 2012* 自然物理学 *8,480-489*	Xiao-song Ma, Stefan Zotter 	quantum steering into the past 量子转向到过去	Experimental delayed-choice entanglement swapping 实验延迟选择纠缠交换 https://arxiv.org/abs/1203.4834	Entanglement can be produced *a posteriori*, after the entangled particles have been measured and may no longer exist. 量子纠缠可以时过境迁后创作出来，换句话说，就是粒子被测量后, 可能已经不存在了.
2003	Tom Campbell American 汤姆.坎贝尔 美国人 	Information data stream 大自然信息数据流供应给众生的觉识	Interpret the Double Split Experiment with Delayed choice quantum eraser as Wave function collapsed by availability of data on the primary detector over the slit reserved for potential observer; not by actual observer.	24:17-38:30 Tom Campbell - The Monroe Institute Lecture https://www.youtube.com/watch?v=5CL_bU4O0A4 Tom Campbell Double Split Experiment with Delayed choice quantum eraser https://www.youtube.com/watch?v=xo176ulPmbY 48:32-1:28 Tom Campbell in Calgary: Theory of MBT (Sat) 1/3

			解释了双缝实验“延迟选择擦掉量子位置信息”的波函数塌缩不是因为目前的观测者存在，而是为了迎合未来会有人观察的可能性。	https://www.youtube.com/watch?v=2NIbro2MNBs

Alfred Nobel born 1833, first Nobel prize 1901
阿尔弗雷德·诺贝尔出生于 1833 年， 首届诺贝尔颁奖是在 1901 年。

Quantum Physics Debunks Materialism 量子物理学破除了唯物主义
https://www.youtube.com/watch?v=ukqc9xNTpx0

Jenny Conclusions:
Light and other electromagnetic waves were emitted in discrete packets of energy, called "quanta". Light is wave-particle duality- both a wave and particle at the same time. Great enlightened scientists/physicists (names mentioned above) have proven that metaphysical phenomenon is reality but most sentient beings are simply too ignorant to be aware of it.
Jenny 总结：
离散的能量包会发射光和其他电磁波，被称为“量子”。光具有波粒二象性，既有波又有粒子。伟大的启蒙科学家/物理学家（上面提到的名字）已经证明了形而上学的现象是真实的，但大多数众生只是太无知，没意识到。

Tammy Conclusions:
This lecture stated different levels of reality in different space time by using light as example. Newton said light is a particle. Thomas Young said light is a wave. As our thinking box grows bigger, we know light is a particle and it behaves like a wave. With Max Born’s double slit experiment, it becomes probability wave because of the interfering pattern. Light's effect is like a wave and its measure phenomenon is like a particle (phenomenology). But the reality itself is probability (ontology). Every dimension has its own reality. This is how science works. New theory will pop out as our thinking box gets bigger (No more fragmentation knowledge). According to Max Planck, Light carries energy as packets quanta which are a constant. Einstein proved Max Planck’s theory with photoelectric effect. The wavelength (frequency) is the power. The quantum is the punch/force. Both represent energy packages (packets of quanta). Probability is only the essence/cause of reality. All this indicate that science is evolving and moving forward. It all depends on how big our thinking box is. But, it is still a long way to go for consciousness. Even though many physicists admit consciousness exists, no one can do anything because they can’t find a way to prove it yet. But, as least it’s getting their attention.
Tammy 总结：
本讲座以光为例，阐述了不同时空中不同层次的现实。牛顿说光是粒子。托马斯· 杨说光是一种波。当我们的思维框越来越大，我们知道光是一个粒子，它的行为像一个波。在马克斯· 玻恩的双缝实验中，因为其干扰模式，它变为概率波。光的作用就像一个波，它的测量现象就像一个粒子（现象学）。但现实本身就是概率（本体论）。每一个维度都有它

自己的现实。这就是科学工作的原理。新的理论会涌现，因为我们的思维框变得更大（没有碎片知识）。
根据马克思.普朗克的说法，光携带的能量是量子常数。爱因斯坦用光电效应证明了普朗克的理论。波长（频率）是功率。量子是冲/力。两者代表能量包（量子数据包）。概率只是现实的本质。所有这一切表明，科学是不断发展和前进的。这要看我们的思维有多大。但是，要成为意识仍有一个很长的路要走。尽管许多物理学家承认意识的存在，但没有人能做任何事情，因为他们无法找到一种方法来证明它。但是，至少是得到了他们的注意。