PHYSICS~452/562--FALL~2022

ATOMIC PHYSICS AND LASERS

Lecture: $T\theta - 11:30 - 12:50$ as of June 20, 2022 Harold Metcalf - S225 - 632-8185 or 8036 Room: Physics S-265 subject to change harold.metcalf@stonybrook.edu Text: van der Straten & Metcalf (Cambridge) find it at https://doi.org/10.1017/CBO9781316106242

Text: Milonni & Eberly, 2nd Edition (Wiley)

Tuesday Thursday Reading & Homework	Week #	Willoui & Eberry, 2 Edition (W.	0 /		
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Historical Background Schrödinger Equation(s) VdS & M: Ch. 1, 2.1, 2.2 Problem set #1	date				
Rabi and Bloch view More on Bloch sphere VdS & M: Ch. 2; M&E: 9.1-9.3	Background in Atomic Physics and Quantum Mechanics.				
Rabi and Bloch view 8/29 for two-level atom Dressed atom picture Prob. set #2	I	Historical Background	Schrödinger Equation(s)	vdS & M: Ch. 1, 2.1, 2.2	
	8/22	Classical models	Multiple solutions	Problem set #1	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$			More on Bloch sphere	vdS & M: Ch. 2,; M&E: 9.1-9.3	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	8/29	for two-level atom	Dressed atom picture	Prob. set #2	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	III	Separate S.E. for H atom	Fine structure	vdS & M: Ch. 7	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$		(Tom Weinacht)	ŭ <u>-</u>	Problem set $\# 3$	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		Atomic Clocks, Ramsey method,	Quantum defects	vdS & M: Ch. 8.1 - 8.5, 8.A, 8.B	
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	9/12	Selection Rules	Other Atoms (Eric Jones)	vdS & M: 10.1 - 10.3 Problem set # 4	
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	V	Hyperfine structure	21 st Century Revolution in	vdS & M: Ch. 3.2.1, 3.3, 3.5, 9.1 - 9.3	
VI 9/26 Stimulated Emission First Mid-term Exam In Class (closed book) M&E - Ch. 10, prob 10.10 & special	9/19	Zeeman, Stark & dipole	Quantum Mechanics	vdS & M: Ch. 11; Problem set #5	
Stimulated Emission In Class (closed book) M&E - Ch. 10, prob 10.10 & special		, ,	Superposition, Entanglement		
Laser Operation and Types of Lasers.	VI	A and B Coefficients	First Mid-term Exam	vdS & M: Ch. 5 and M & E: Sec. 3.7	
VII	9/26	Stimulated Emission	In Class (closed book)	M&E - Ch. 10, prob 10.10 & special	
Three and Four levels Gain - Rate Eq's Saturated Absorption Spect. VIII NO CLASS HOLIDAY Segin Tunable & Dye Lasers Gaussian Beams and Solid State Lasers Ti:Sapphire, DPSS, and Semiconductor Lasers Applications of Lasers Applications of Lasers - Nobel Prizes. XII Fiber Optics & Lasers - Limits I1/14 Lattices For Neutral Atoms XIV Second Mid-term Exam Solid State Lasers And E, Ch. 4, Sec's. 1-12 M & E, prob's. 3.10, 4.1 M & E, prob's. 3.10, 4.1 M & E, prob's. 3.10, 4.1 M & E, prob's. 5.8 - 5.11 M&E, 7.1-7.9, espec. 7.5 & Table 7.1 prob's 7.1, 7.3a, 7.4; prove Eq. 7.5.6 M & E, prob's. 11.4, 11.7, 11.9 M & E, prob's 1.4, 11.17 M & E, prob's. 11.4, 11.7, 11.9 M & E, prob's	Laser Operation and Types of Lasers.				
Gain - Rate Eq's Saturated Absorption Spect. M & E, prob's. 3.10, 4.1	VII	Introduction to Lasers	Longitudinal Modes,	M & E, Ch. 1	
VIII NO CLASS Gas Lasers: HeNe, CO ₂ , Ar ⁺ M&E, Sec's. 5.8 - 5.11	10/3	Three and Four levels	Single Mode - Lamb dip	M & E, Ch. 4, Sec's. 1-12	
HOLIDAY Begin Tunable & Dye Lasers M&E, 7.1-7.9, espec. 7.5 & Table 7.1 prob's 7.1, 7.3a, 7.4; prove Eq. 7.5.6		Gain - Rate Eq's	Saturated Absorption Spect.	M & E, prob's. 3.10, 4.1	
IX Gaussian Beams and Confocal Resonators cont'd M&E, 11.3 - 11.11 10/17 Dye Laser Resolution Fabry-Perot Resonators Ring Laser Cavities X Solid State Lasers I & T dependence for diodes Semiconductor Lasers & Pound-Drever-Hall XI Non-Linear Optics Mode Locked Lasers Pulsed & Freq. Comb Applications of Lasers - Nobel Prizes. XII Fiber Optics & Lasers - Limits I Laser Cooling & Temp. Limit I Trapping and Confinement I M&E 14.4 - 14.6 Optical Tweezers I Texperior of the Application of the Applications of CLASS XIV Second Mid-term Exam Confocal Resonators cont'd M&E, 11.3 - 11.11 M&E, 11.3 - 11.11 M&E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's - Catch up M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 No & E, prob's. 11.4, 11.7, 11.9 No & E, prob's. 11.4, 11.7, 11.9 M&E, 11.12 - 11.15 No & E, prob's. 11.4, 11.7, 11.9 No & E	VIII		Gas Lasers: HeNe, CO ₂ , Ar ⁺	M&E, Sec's. 5.8 - 5.11	
IXGaussian Beams and 10/17Confocal Resonators cont'd Dye Laser Resolution Fabry-Perot ResonatorsConfocal Resonators cont'd More About Tunable Lasers Ring Laser CavitiesM&E, 11.3 - 11.11 M&E, prob's. 11.4, 11.7, 11.9XSolid State Lasers 10/24I & T dependence for diodes Ti:Sapphire, DPSS, and Semiconductor LasersI & T dependence for diodes Saturated Abs., Modulators, & Pound-Drever-HallM & E, 11.12 - 11.15 no prob's - catch upXINon-Linear Optics Harmonic GenerationMode Locked Lasers Pulsed & Freq. CombTBAXIIFiber Optics & Lasers - Limits to Telecom - NanofibersLaser Cooling & Temp. Limit Breaking the LimitM&E 8.6, 8.7, 14.7XIIIMagnetic Traps & Optical 11/14Trapping and Confinement Optical TweezersM&E 14.4 - 14.6 prepare for examXIVSecond Mid-term ExamNO CLASSM&E All of ch. 14; prob's 14.6, 14.8a,	10/10	HOLIDAY	Begin Tunable & Dye Lasers	M&E, 7.1-7.9, espec. 7.5 & Table 7.1	
Dye Laser Resolution Fabry-Perot Resonators Ring Laser Cavities				prob's 7.1, 7.3a, 7.4; prove Eq. 7.5.6	
Fabry-Perot Resonators Ring Laser Cavities	IX	Gaussian Beams and	Confocal Resonators cont'd	M&E, 11.3 - 11.11	
X Solid State Lasers I & T dependence for diodes 10/24 Ti:Sapphire, DPSS, and Semiconductor Lasers & Pound-Drever-Hall XI Non-Linear Optics Mode Locked Lasers Pulsed & Freq. Comb Applications of Lasers - Nobel Prizes. XII Fiber Optics & Lasers - Limits 11/7 to Telecom - Nanofibers Breaking the Limit XIII Magnetic Traps & Optical 11/14 Lattices For Neutral Atoms Optical Tweezers Problem 11/14 Second Mid-term Exam I & T dependence for diodes M & E, 11.12 - 11.15 no prob's - catch up M & E, 11.12 - 11.15 no prob's - catch up M & E, 11.12 - 11.15 no prob's - catch up M & E, 11.12 - 11.15 no prob's - catch up M & E, 11.12 - 11.15 no prob's - catch up TBA TBA Pulsed & Freq. Comb Applications of Lasers - Nobel Prizes. XIII Fiber Optics & Lasers - Limits Breaking the Limit M&E 8.6, 8.7, 14.7 Trapping and Confinement M&E 14.4 - 14.6 Optical Tweezers prepare for exam XIV Second Mid-term Exam NO CLASS M&E All of ch. 14; prob's 14.6, 14.8a,	10/17	Dye Laser Resolution	More About Tunable Lasers	M & E, prob's. 11.4, 11.7, 11.9	
Ti:Sapphire, DPSS, and Saturated Abs., Modulators, Semiconductor Lasers & Pound-Drever-Hall XI		Fabry-Perot Resonators	Ring Laser Cavities		
Semiconductor Lasers & Pound-Drever-Hall XI	X	Solid State Lasers	I & T dependence for diodes	M & E, 11.12 - 11.15	
XI	10/24	Ti:Sapphire, DPSS, and	Saturated Abs., Modulators,	no prob's - catch up	
Harmonic GenerationPulsed & Freq. CombApplications of Lasers - Nobel Prizes.XIIFiber Optics & Lasers - LimitsLaser Cooling & Temp. LimitM&E 8.6, 8.7, 14.711/7to Telecom - NanofibersBreaking the LimitXIIIMagnetic Traps & Optical 11/14Trapping and Confinement Lattices For Neutral AtomsM&E 14.4 - 14.6 Optical TweezersXIVSecond Mid-term ExamNO CLASSM&E All of ch. 14; prob's 14.6, 14.8a,		Semiconductor Lasers			
Applications of Lasers - Nobel Prizes. XII Fiber Optics & Lasers - Limits Laser Cooling & Temp. Limit M&E 8.6, 8.7, 14.7 11/7 to Telecom - Nanofibers Breaking the Limit XIII Magnetic Traps & Optical Trapping and Confinement M&E 14.4 - 14.6 11/14 Lattices For Neutral Atoms Optical Tweezers prepare for exam XIV Second Mid-term Exam NO CLASS M&E All of ch. 14; prob's 14.6, 14.8a,	XI	Non-Linear Optics	Mode Locked Lasers	TBA	
XII Fiber Optics & Lasers - Limits to Telecom - Nanofibers XIII Magnetic Traps & Optical Trapping and Confinement Lattices For Neutral Atoms XIV Second Mid-term Exam Laser Cooling & Temp. Limit M&E 8.6, 8.7, 14.7 Breaking the Limit M&E 14.4 - 14.6 Optical Tweezers prepare for exam NO CLASS M&E All of ch. 14; prob's 14.6, 14.8a,	10/31	Harmonic Generation	Pulsed & Freq. Comb		
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XIII Magnetic Traps & Optical Trapping and Confinement M&E 14.4 - 14.6	11/7	to Telecom – Nanofibers	Breaking the Limit		
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XIV Second Mid-term Exam NO CLASS M&E All of ch. 14; prob's 14.6, 14.8a,	11/14	Lattices For Neutral Atoms		prepare for exam	
11/21 In Class (closed book) THANKSGIVING 14.6 14.8a 14.9a b 14.11 14.14 14.21		Second Mid-term Exam	NO CLASS		
11/21	11/21	In Class (closed book)	THANKSGIVING	14.6, 14.8a, 14.9a,b, 14.11, 14.14, 14.21	
XV Bose-Einstein Resolution Limits M&E All of ch. 14; prob's 14.6, 14.8a,		Bose-Einstein	Resolution Limits	M&E All of ch. 14; prob's 14.6, 14.8a,	
11/28 Condensation 14.6, 14.8a, 14.9a,b, 14.11, 14.14, 14.21	11/28	Condensation		14.6, 14.8a, 14.9a,b, 14.11, 14.14, 14.21	

(Required Statement)

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Any suspected instance of academic dishonesty will be reported to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

How the Course is Graded

HOMEWORK

Homework problems will be assigned regularly from either distribution in class (and posting on Blackboard) or taken from the text by Milonni and Eberly. They will be graded only when they're received on paper. The earlier assignments submitted by email overtaxed my printer (it's not a commercial printer) so I will no longer print and grade them. They need to be submitted on time by email, followed by paper mailed versions that will be checked against the email and then graded. Any other way of getting the paper version to me is OK.

EXAMS

There will be two exams, currently scheduled for 30 September and 23 November (subject to change). This is designated as an in-person course but I have accommodated several requests to take the classes remotely. However, exams will be given at announced times in the classroom (S-265). Exemptions from this policy can be granted only by the Student Accessibility Support Center (SASC).

GRADES

Grades will be based approximately equally on these two aspects of the course, with a boost given to those students who participate actively in class.