

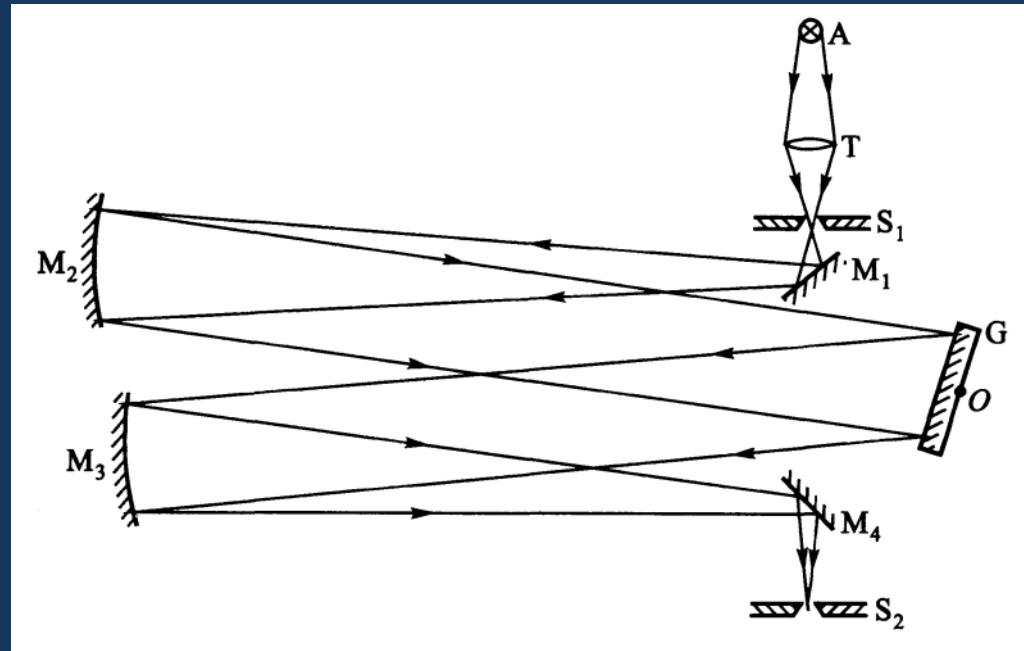
类氢光谱

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指导老师： 姚红英

平面光栅光谱仪

- 测量范围 200 – 660 nm
 - 精度 0.01 nm
- 参数选择
 - 入射狭缝 S_1 宽度 d_1
 - 出射狭缝 S_2 宽度 d_2
 - 决定分辨率
 - 光电倍增管负高压 U
 - 决定信号强度
- 定标
- 光谱数据来源
 - <http://physics.nist.gov/PhysRefData/ASD>



氢光谱

- 里德伯公式

$$\tilde{\nu} = \frac{1}{\lambda} = R_{\infty} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \quad n_1 = 1, 2, 3 \dots \quad n_2 = n+1, n+2, n+3 \dots$$

- 里德伯常数 R_{∞}

$$R_{\infty} = \frac{2\pi^2 e^4 m_e}{(4\pi\epsilon_0)^2 ch^3} = 1.0973731568539 \times 10^7 \text{ m}^{-1}$$

- 约化质量修正

$$m_e \rightarrow \mu = \frac{m_e m_X}{m_e + m_X} \quad R_X = R_{\infty} \frac{m_X}{m_e + m_X}$$

氢光谱

- 巴耳末系($n_1 = 2, n_2 = 3, 4, 5 \dots$)

$$\tilde{\nu} = \frac{1}{\lambda} = R_X \left(\frac{1}{2^2} - \frac{1}{n^2} \right)$$

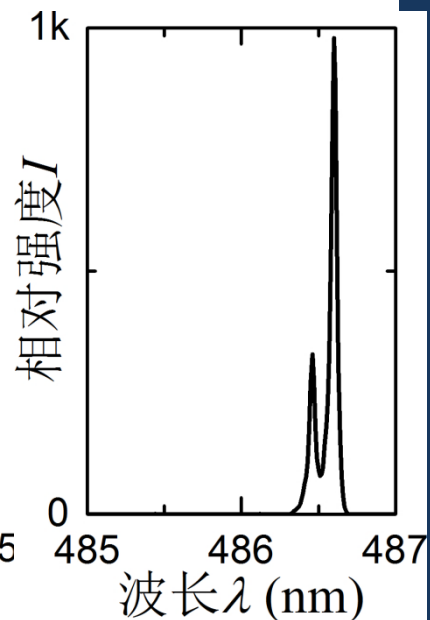
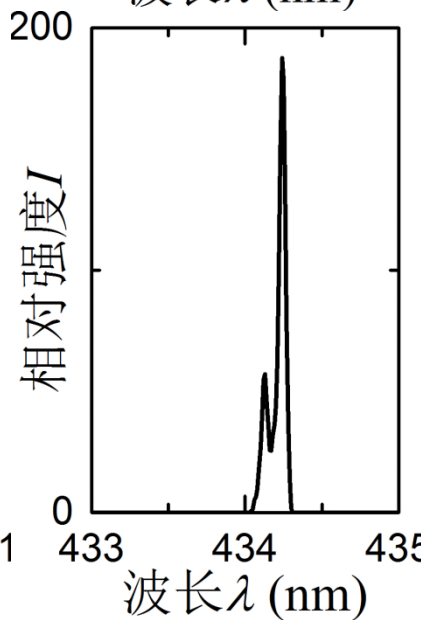
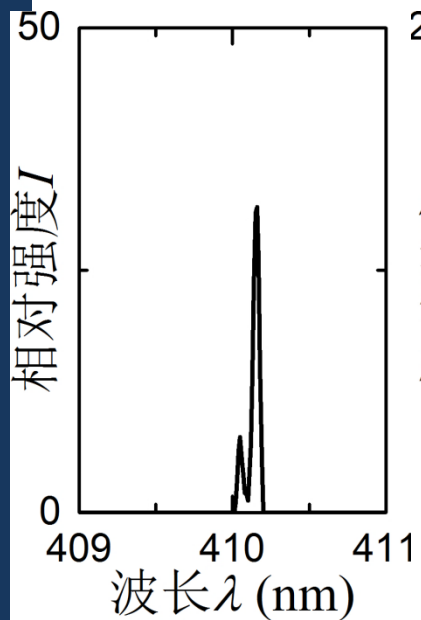
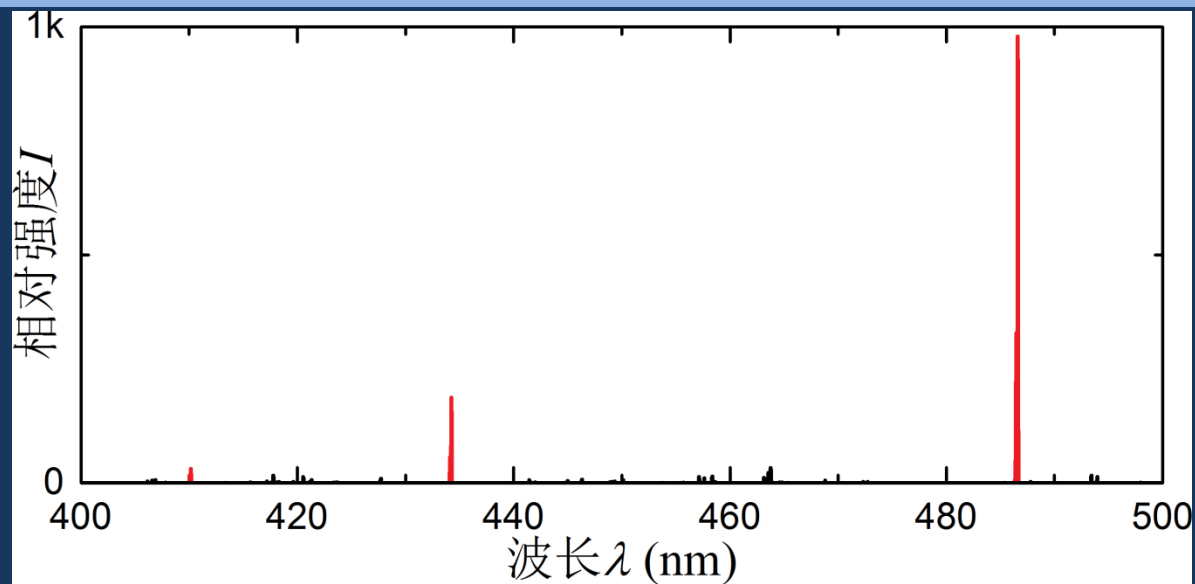
- 氢 $R_H = R_\infty \frac{m_H}{m_e + m_H}$

- 氘 $R_D = R_\infty \frac{m_D}{m_e + m_D}$

$$m_D = 2m_H$$

- 同位素位移

氢光谱



氢光谱

谱线	n	测量波长(nm)	理论波长(nm)	偏差(nm)
D_δ	6	410.05	410.062	-0.012
H_δ	6	410.16	410.174	-0.014
D_γ	5	434.13	433.928	0.202
H_γ	5	434.24	434.047	0.193
D_β	4	486.46	486.000	0.460
H_β	4	486.60	486.133	0.467

钠光谱

- 跃迁选择定则
 - $\Delta l = \pm 1$
 - $\Delta j = 0, \pm 1$
- 主要谱线系
 - 主线系: $nP \rightarrow 3S$ ($n \geq 3$)
 - 锐线系: $nS \rightarrow 3P$ ($n \geq 4$)
 - 漫线系: $nD \rightarrow 3P$ ($n \geq 3$)
 - 基线系: $nF \rightarrow 3D$ ($n \geq 4$)

钠光谱

- 量子数修正

- $n \rightarrow n' = n + \Delta$ 其中 $\Delta < 0$ ，称为量子亏损
- 里德伯公式

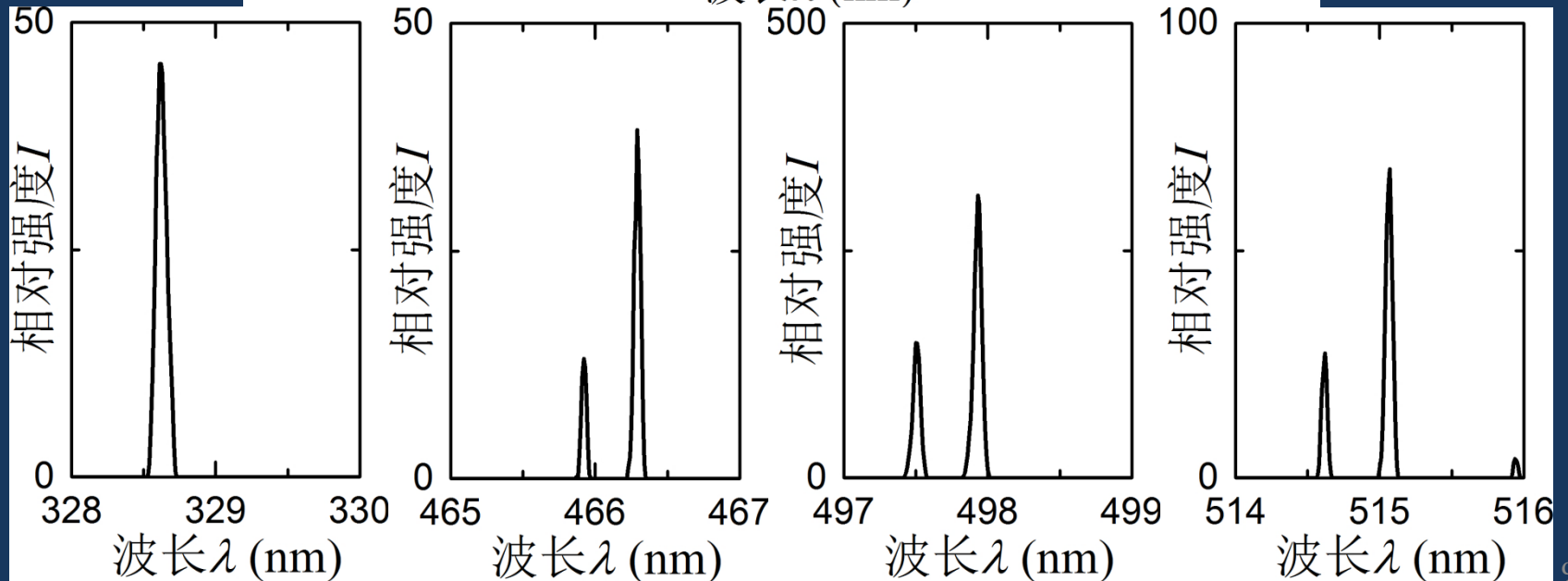
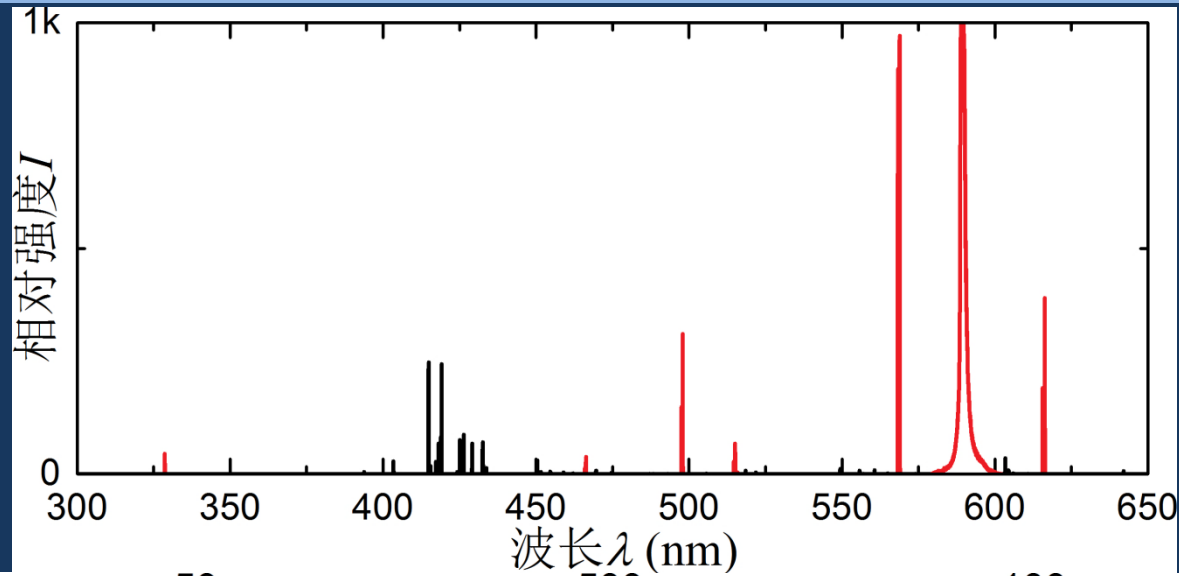
$$\tilde{\nu} = \frac{1}{\lambda} = R_{\infty} \left(\frac{1}{(n_1 + \Delta_1)^2} - \frac{1}{(n_2 + \Delta_2)^2} \right)$$

- 计算量子亏损方法

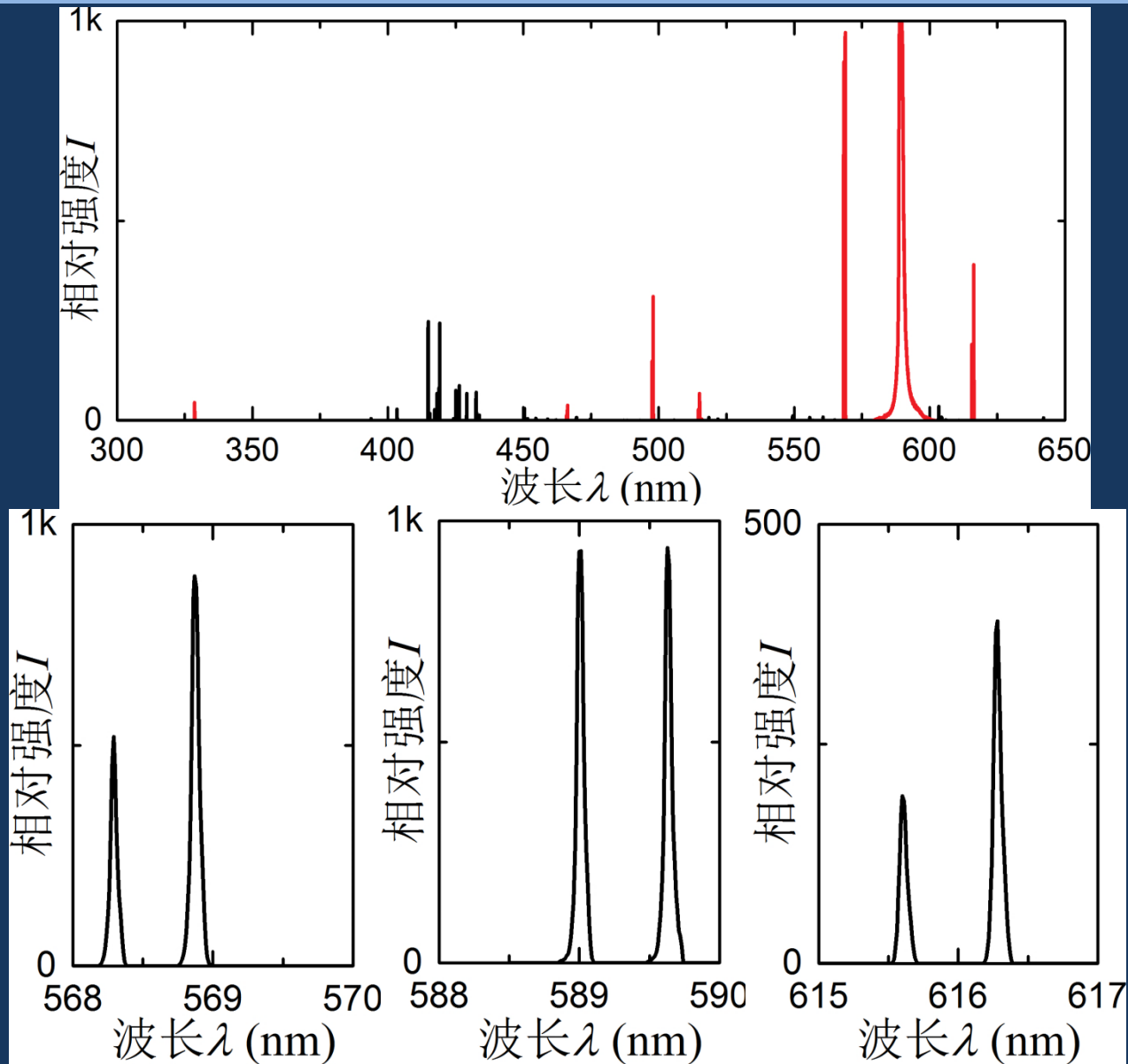
- 同一谱线系中相邻谱线波数差

$$\tilde{\nu}_{n+1} - \tilde{\nu}_n = R_{\infty} \left(\frac{1}{(n + \Delta)^2} - \frac{1}{(n + 1 + \Delta)^2} \right)$$

钠光谱



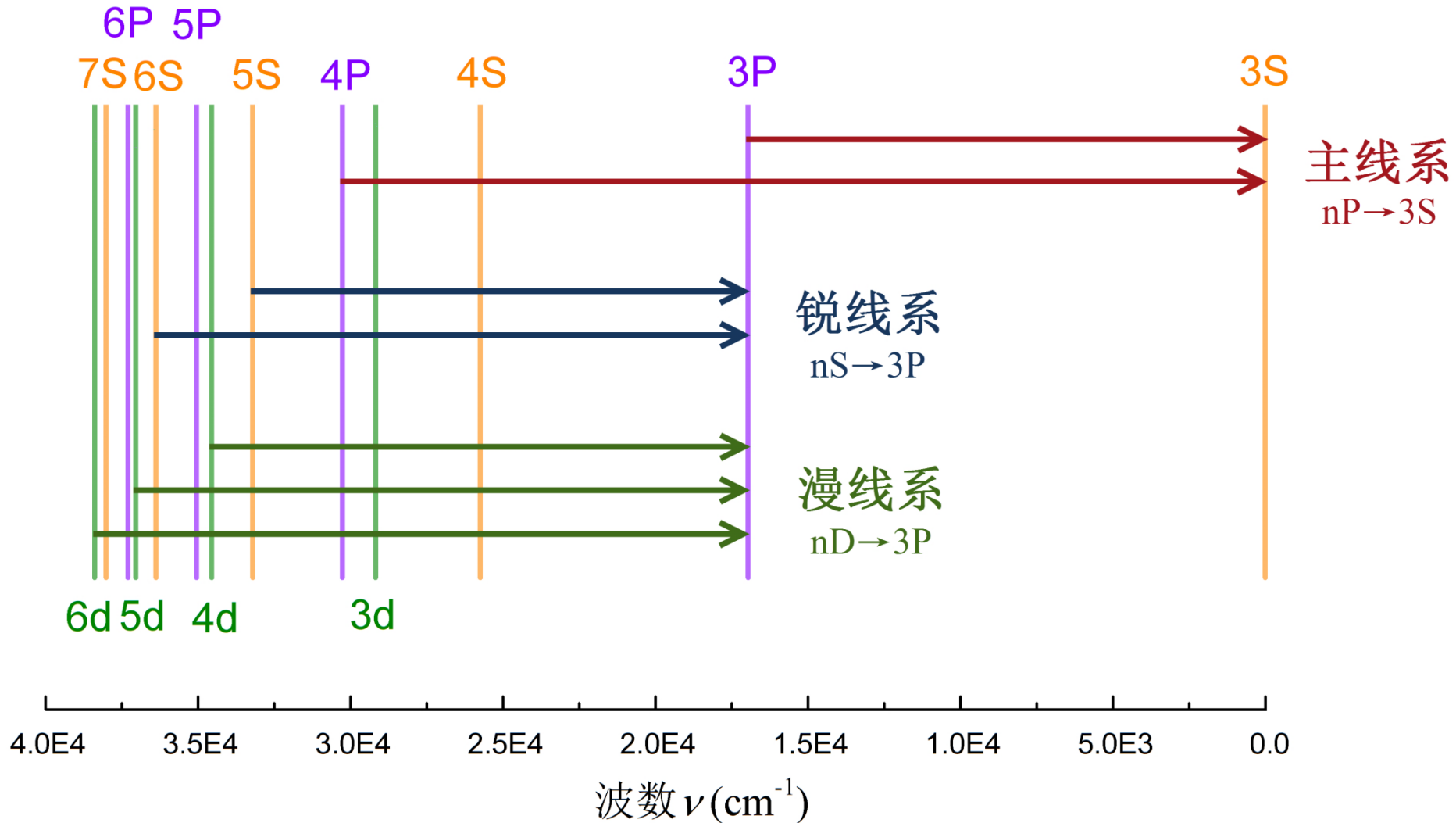
钠光谱



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谱线	跃迁	测量波长(nm)	理论波长(nm)	偏差(nm)	测量强度	理论强度	量子亏损
主线系	$3P_{3/2} \rightarrow 3S_{1/2}$	589.01	588.995	0.015	0.992	2	
	$3P_{1/2} \rightarrow 3S_{1/2}$	589.63	589.592	0.038	1	1	
	$4P_{3/2} \rightarrow 3S_{1/2}$	328.61	330.237	-1.627		2	
	$4P_{1/2} \rightarrow 3S_{1/2}$		330.298			1	-0.900
锐线系	$5S_{1/2} \rightarrow 3P_{1/2}$	615.60	615.423	0.177	1	1	
	$5S_{1/2} \rightarrow 3P_{3/2}$	616.28	616.075	0.205	2.042	2	
	$6S_{1/2} \rightarrow 3P_{1/2}$	514.62	514.884	-0.264	1	1	
	$6S_{1/2} \rightarrow 3P_{3/2}$	515.07	515.340	-0.270	2.478	2	-1.361
漫线系	$4D_{3/2} \rightarrow 3P_{1/2}$	568.29	568.263	0.027	1	5	
	$4D_{3/2} \rightarrow 3P_{3/2}$		568.819			1	
	$4D_{5/2} \rightarrow 3P_{3/2}$	568.87	568.820	0.050	1.701	9	
	$5D_{3/2} \rightarrow 3P_{1/2}$	497.50	497.854	-0.354	1	5	
	$5D_{3/2} \rightarrow 3P_{3/2}$		498.281			1	-0.021
	$5D_{5/2} \rightarrow 3P_{3/2}$	497.93	498.281	-0.351	2.089	9	
	$6D_{3/2} \rightarrow 3P_{1/2}$	465.92	466.481	-0.561	1	5	
$6D_{3/2} \rightarrow 3P_{3/2}$		466.856			1	-0.029	
$6D_{5/2} \rightarrow 3P_{3/2}$	466.29	466.856	-0.566	2.902	9		

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谢谢