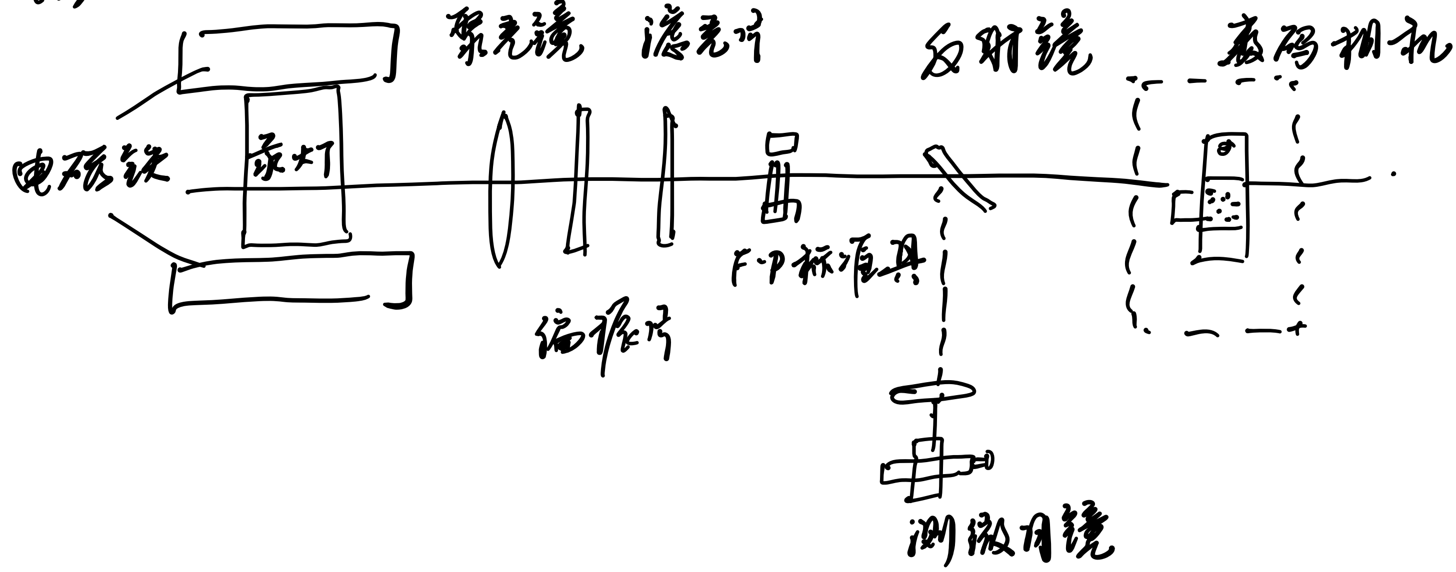
塞曼效应预习作业

鲁睿 未央-软11
2021012539

(1)

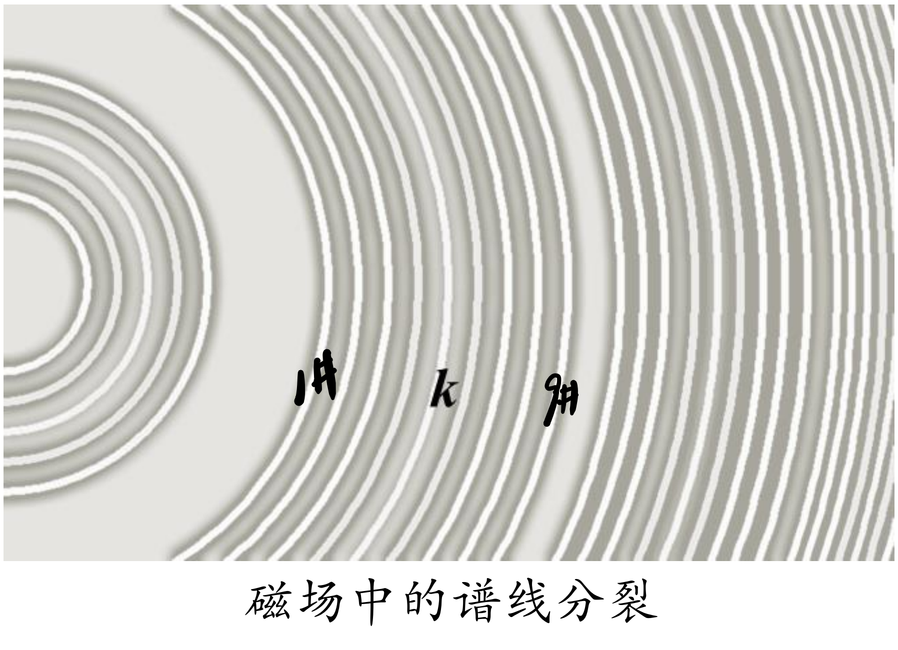


测量装置示意图

(2) 由等厚干涉相长条件. $2d\cos\theta = k\lambda$.

由三角函数关系，当直径增加时，θ增加，$\cos\theta$减少，k减少

即从中央往外，干涉环的直径增加，级次减少。



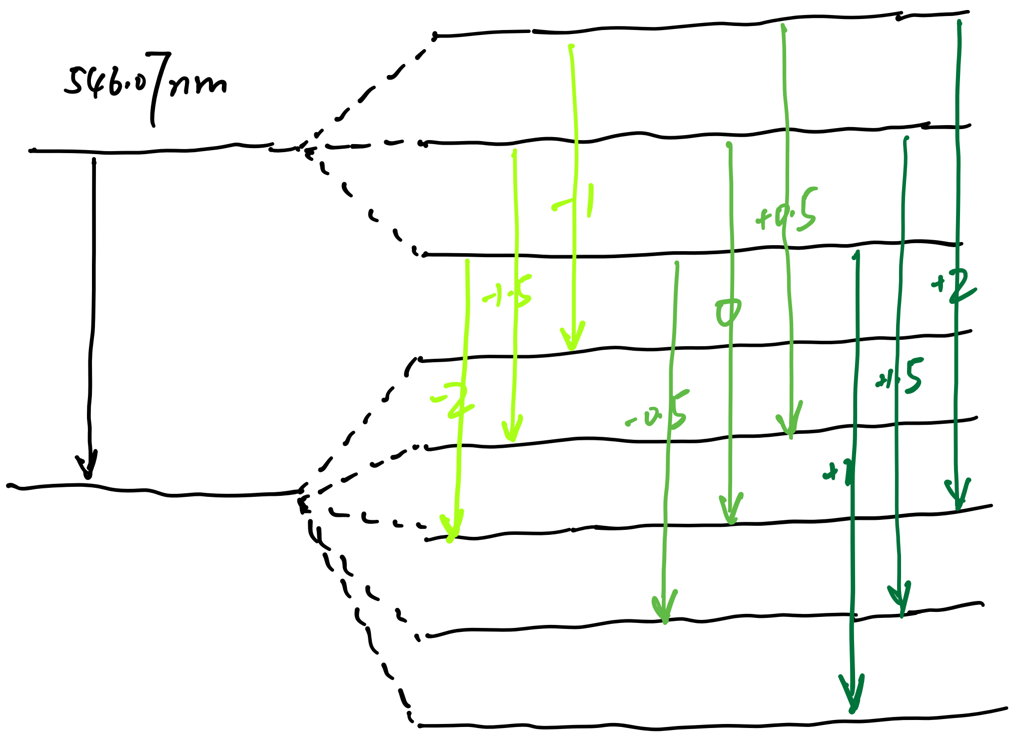
磁场中的谱线分裂

由于频率越高，波长λ越小，相同级次处 $2d\cos\theta$ 变小，
对应θ越大，直径越大，故标注如上。

对上能级，$L=0, S=1, J=1$. $g_上 = 1+\dfrac{J(J+1)-L(L+1)+S(S+1)}{2J(J+1)} = 2$

对下能级，$L=1, S=1, J=2$. $g_下 = 1+\dfrac{J(J+1)-L(L+1)+S(S+1)}{2J(J+1)} = 1.5$

对 546.1nm 绿线分裂之后的9条谱线.



M	Mg
1	2
0	0
-1	-2
2	3
1	1.5
0	0
-1	-1.5
-2	-3

	$\Delta M=-1$	$\Delta M=0$	$\Delta M=1$
垂直于磁场方向	圆偏振	线偏振	圆偏振
	σ-光	π光	σ+光

π光有3条分裂谱线，σ光有6条分裂谱线。

旋转偏振片，通过观察条纹来区分σ光和π光

(3) 绘制数据表格如下：

塞曼效应原始数据

未央软-11 鲁睿

电流/A	k-1, λ1, 左	k-1, λ1, 右	k, λ2, 左	k, λ2, 右	k, λ1, 左	k, λ1, 右	D(k-1, λ1)	D(k, λ2)	D(k, λ1)	δv	B/T
3.50											
2.50											
3.00											
4.00											

由 $\delta\sigma = \frac{1}{2}B\left(\frac{\mu_B}{hc}\right)$ 以及 $\Delta\left(\frac{1}{\lambda}\right) = \frac{1}{2d} \frac{D_k^2(\lambda_2) - D_k^2(\lambda_1)}{D_{k-1}^2(\lambda_1) - D_k^2(\lambda_1)}$

$\downarrow$

$46.686\ m^{-1}J^{-1}$. 选择清晰的两条谱线环

可得: $B = \frac{2}{46.686} \cdot \frac{1}{2d} \frac{D_k^2(\lambda_2) - D_k^2(\lambda_1)}{D_{k-1}^2(\lambda_1) - D_k^2(\lambda_1)}$

需要测量 k 级 λ_1, λ_2 波长对应位置 (左右相减为直径)

以及电流, 计算 $\delta\nu$, 从而得磁感应强度

[推导 $\delta\nu$ 的过程: 近似 $\cos\theta \approx 1 - \frac{1}{2}\theta^2$

$$\left.\begin{aligned} &\forall\ \theta, \lambda.\quad 2d\left(1-\frac{1}{2}\theta^2\right) = k\lambda \\ &f\theta = \frac{D}{2} \end{aligned}\right\} \Rightarrow k\lambda = 2d\left(1 - \frac{1}{2}\frac{D^2}{4f^2}\right)$$

$$\left.\begin{aligned} k\lambda_1 &= 2d\left(1-\frac{1}{2}\frac{D_k^2}{4f^2}\right) \\ (k-1)\lambda_1 &= 2d\left(1-\frac{1}{2}\frac{D_{k-1}^2}{4f^2}\right) \end{aligned}\right\} \Rightarrow \lambda_1 = d\,\frac{D_{k-1}^2(\lambda_1) - D_k^2(\lambda_1)}{4f^2}$$

$$\left.\begin{aligned} k\lambda_1 &= 2d\left(1-\frac{1}{2}\frac{D_k^2}{4f^2}\right) \\ k\lambda_2 &= 2d\left(1-\frac{1}{2}\frac{D_k^2(\lambda_2)}{4f^2}\right) \end{aligned}\right\} \Rightarrow k(\lambda_1 - \lambda_2) = d\,\frac{D_k^2(\lambda_2) - D_k^2(\lambda_1)}{4f^2}$$

近似. $k\lambda = 2d\cos\theta \approx 2d \Rightarrow k = \frac{2d}{\lambda_2}$

$$\Rightarrow \frac{k(\lambda_1-\lambda_2)}{\lambda_1} = 2d\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right) = \frac{D_k^2(\lambda_2) - D_k^2(\lambda_1)}{D_{k-1}^2(\lambda_1) - D_k^2(\lambda_1)} \Rightarrow \Delta\left(\frac{1}{\lambda}\right) = \cdots$$]