核磁共振成像及其应用

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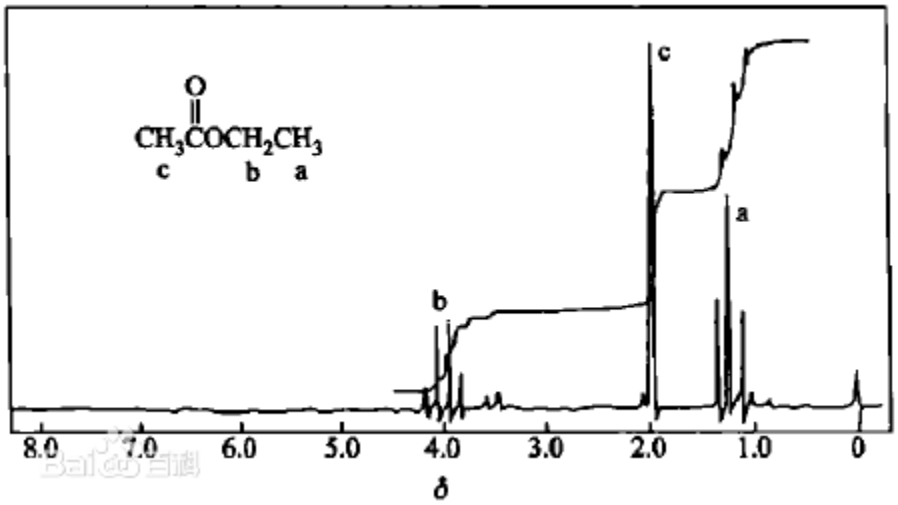
研究背景

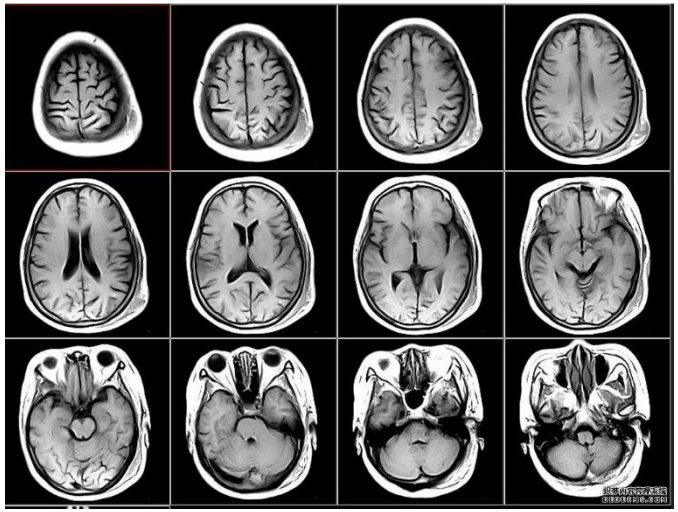
- 医学方面的应用
- 有机物研究的应用

有机物的研究



通过不同基团中的H、C共振频率不同来进行分辨

核磁共振成像



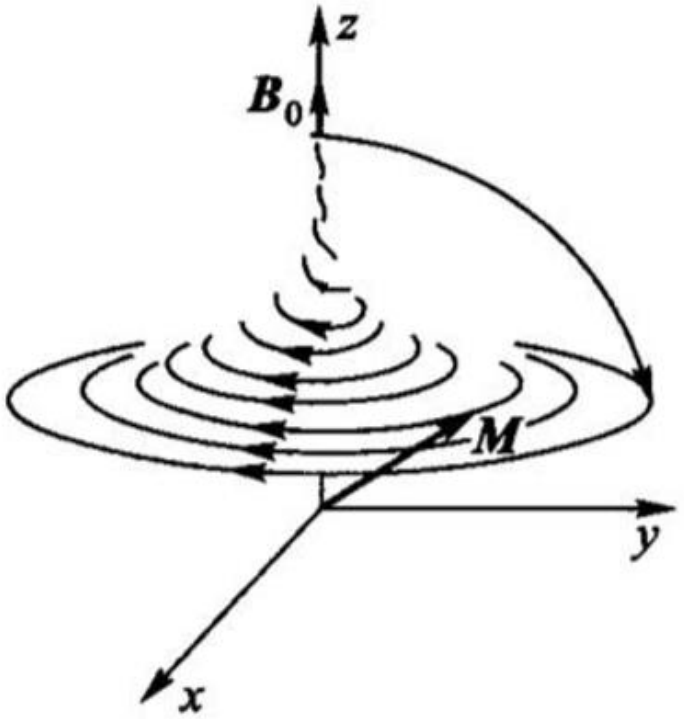
核磁共振成像是一种利用核磁共振原理的最新医学影像新技术，与其他辅助检查手段相比，核磁共振具有成像参数多、扫描速度快、组织分辨率高和图像更清晰等优点

核磁共振原理

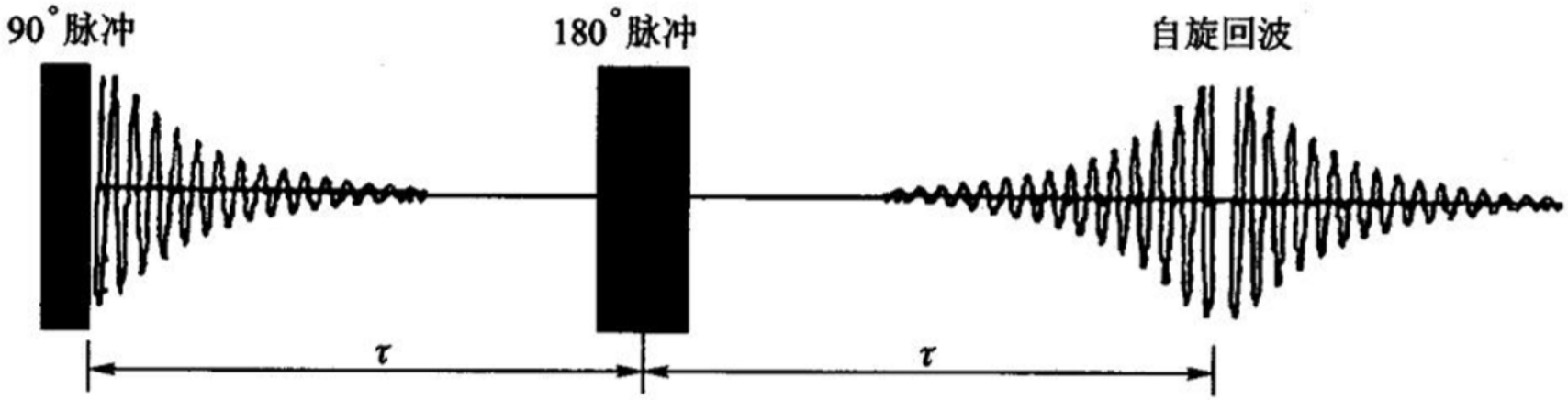
- 弛豫
- 自旋回波

弛豫

粒子受到激发后，以非辐射的方式回到基态而达到玻尔兹曼平衡的过程



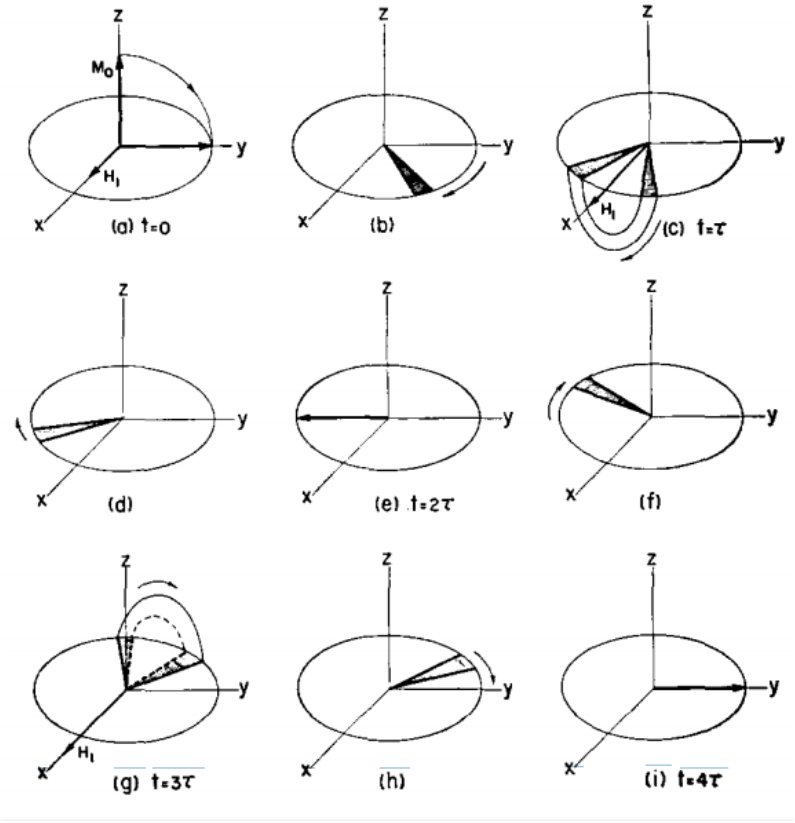
自旋回波



通过 180°脉冲自旋将自旋重聚焦，产生下一次自旋回波信号

CPMG序列

在y方向不断施加flip的场，减小弛豫时间



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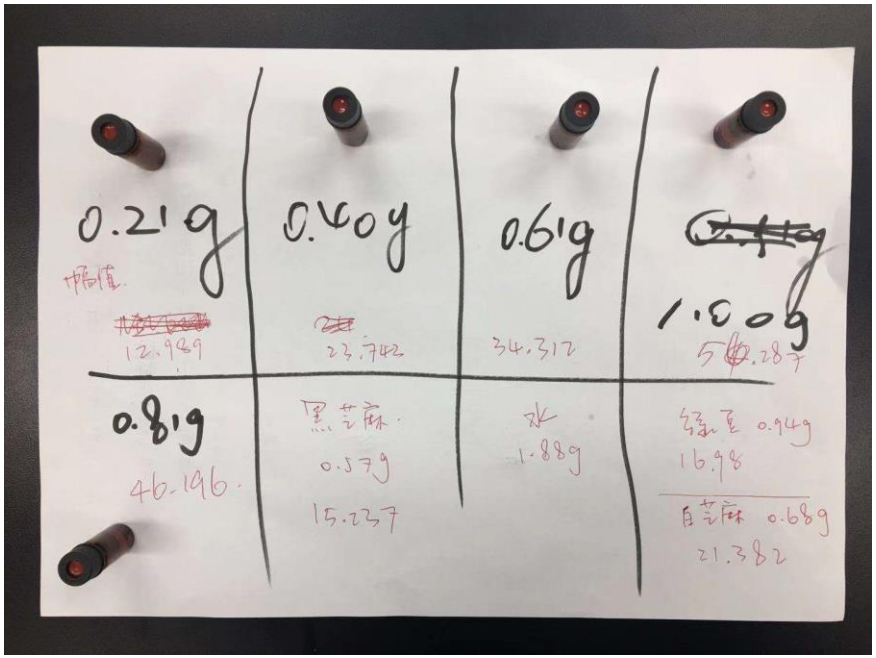
芝麻含油量的测定

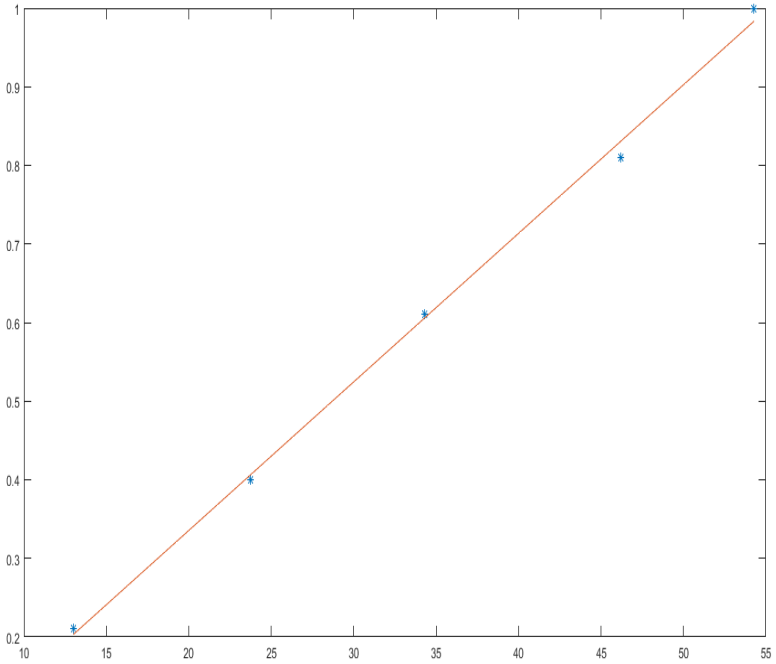


使用实验室提供的芝麻油制备了质量不同的样品，使用CPMG回波序列并观察回波

拟合结果

f(x) = p1*x + p2
Coefficients (with 95% confidence bour
p1 = 0.0189 (0.01734, 0.02046)
p2 = -0.0424 (-0.1008, 0.01602)

Goodness of fit:
SSE: 0.0008
R-square: 0.998
Adjusted R-square: 0.9973
RMSE: 0.01633



脂肪的测定

0.68g白芝麻

样品脂肪含量:0.3517g

百分比51.72%

0.57g黑芝麻

样品脂肪含量:0.2456g

百分比43.08%

0.94g绿豆

样品脂肪含量:0.2785g

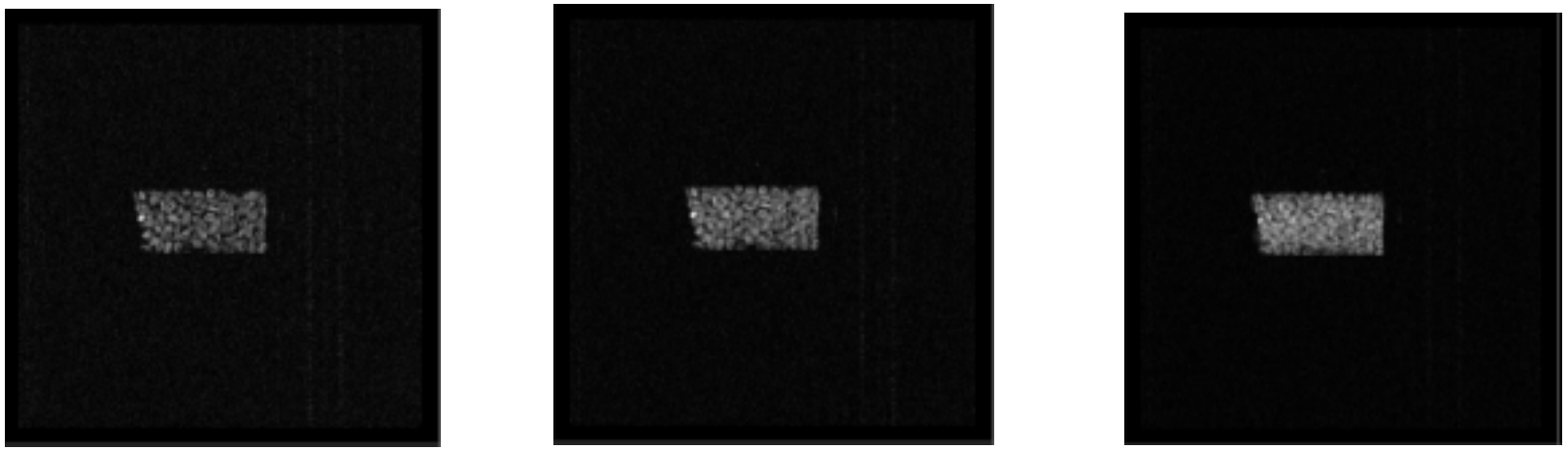
百分比29.63%

成像原理

- 选片
- 编码
- 傅里叶变换

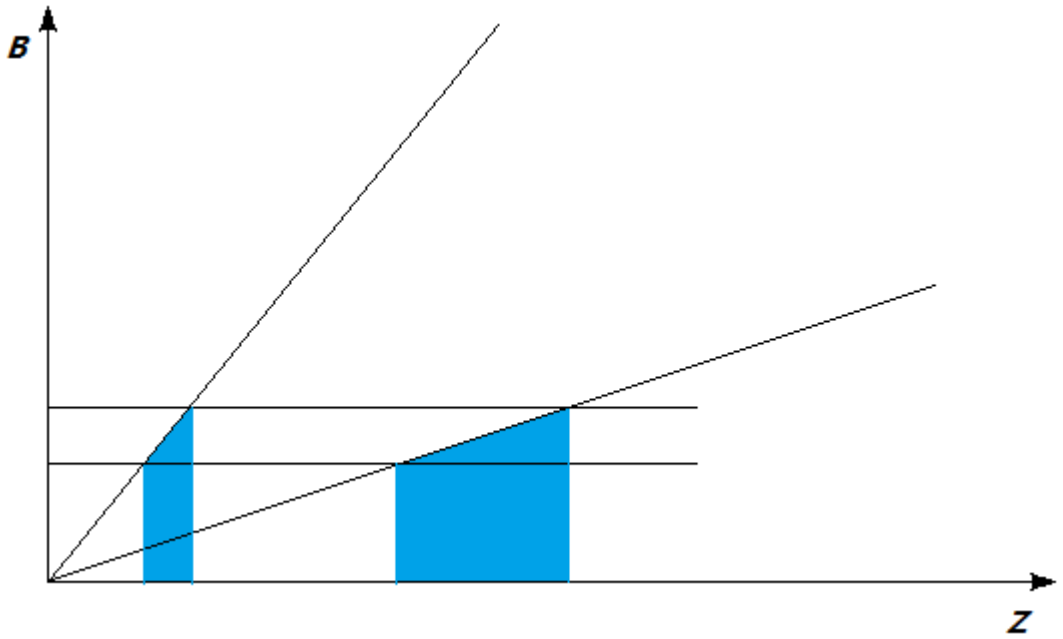
$$\omega_0 = \gamma B_0$$

Z方向梯度（选片厚度）



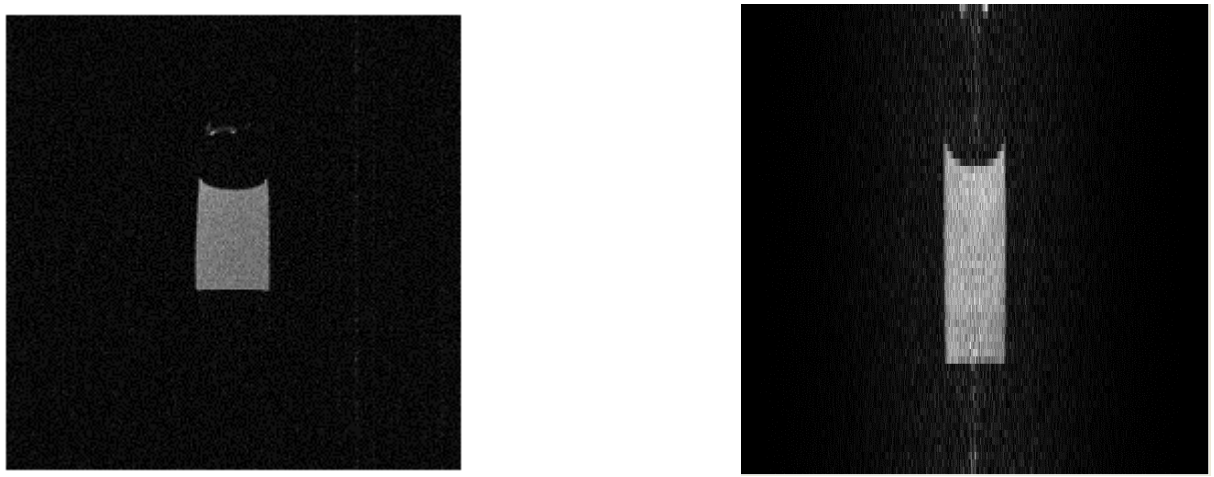
Z方向磁场梯度的影响

Z方向梯度（选片厚度）



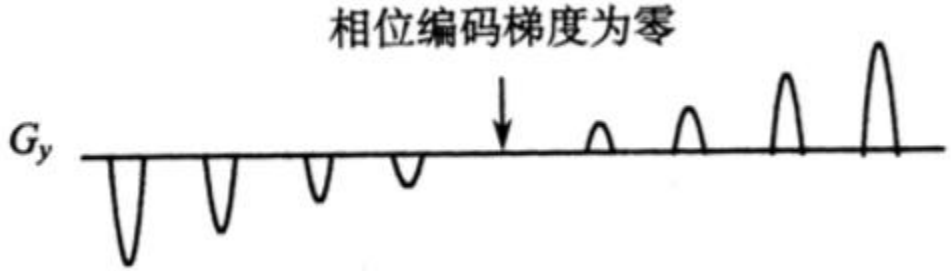
Z方向磁场梯度示意

Y方向（相位编码）

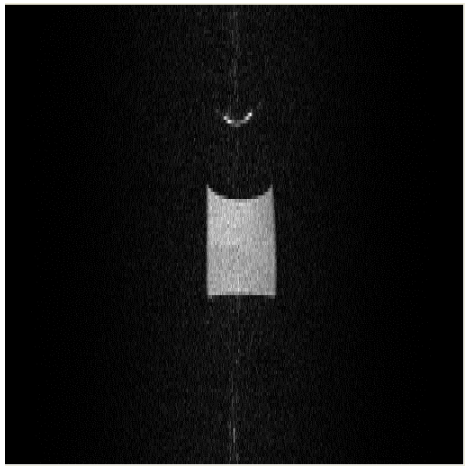


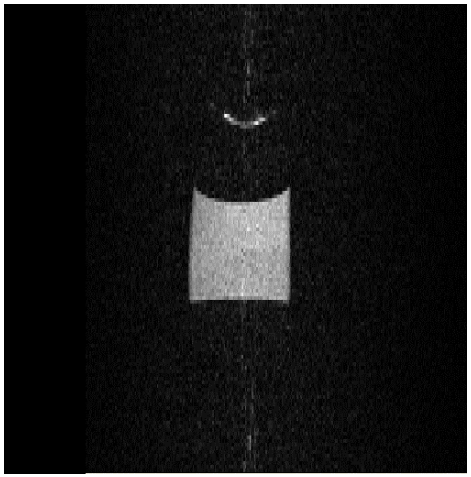
y方向磁场梯度的影响

Y方向（相位编码）



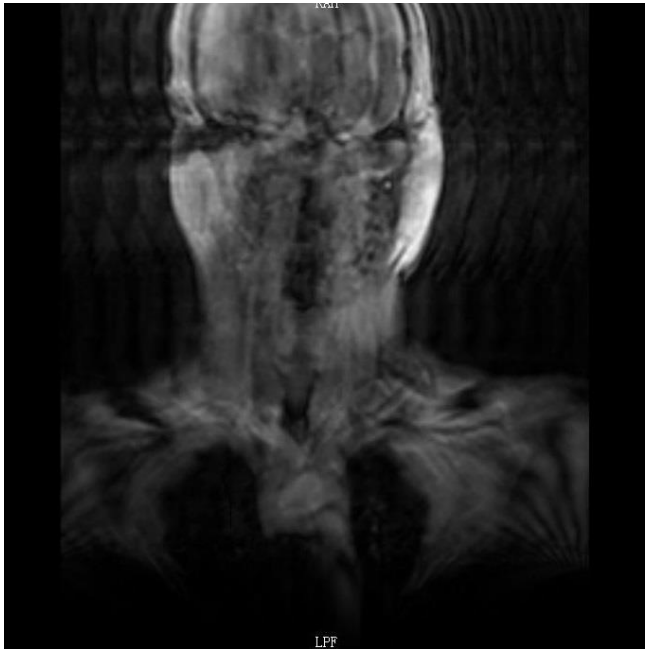
X方向（频率编码）





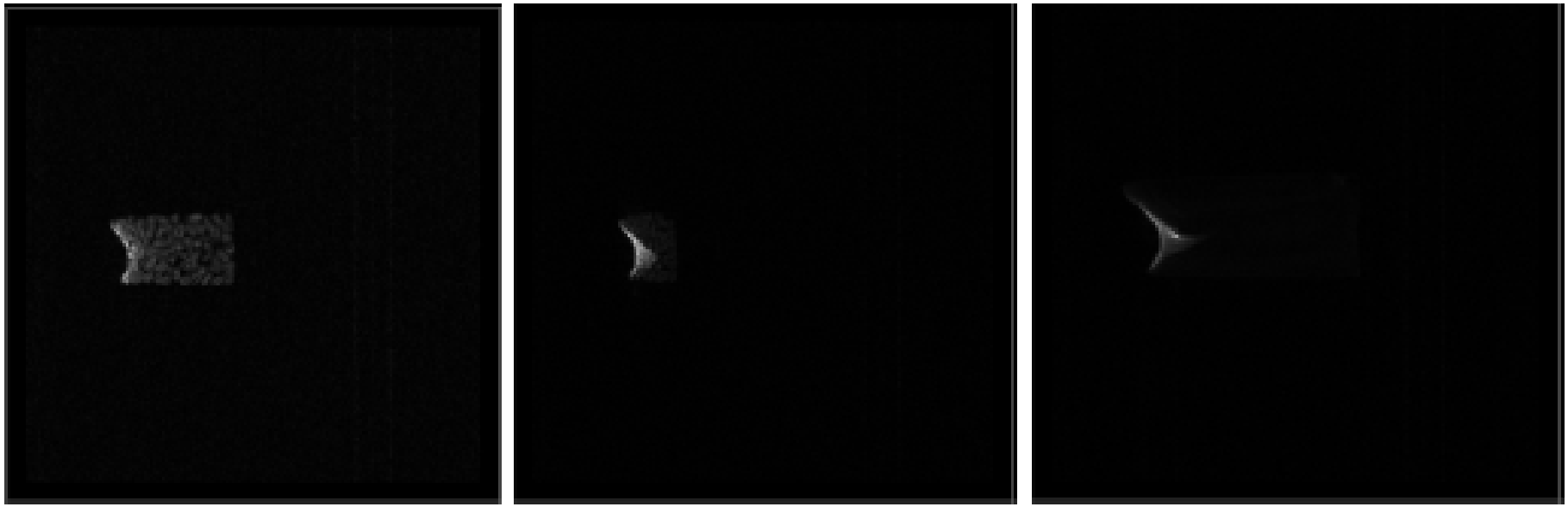
y方向磁场梯度的影响

伪影



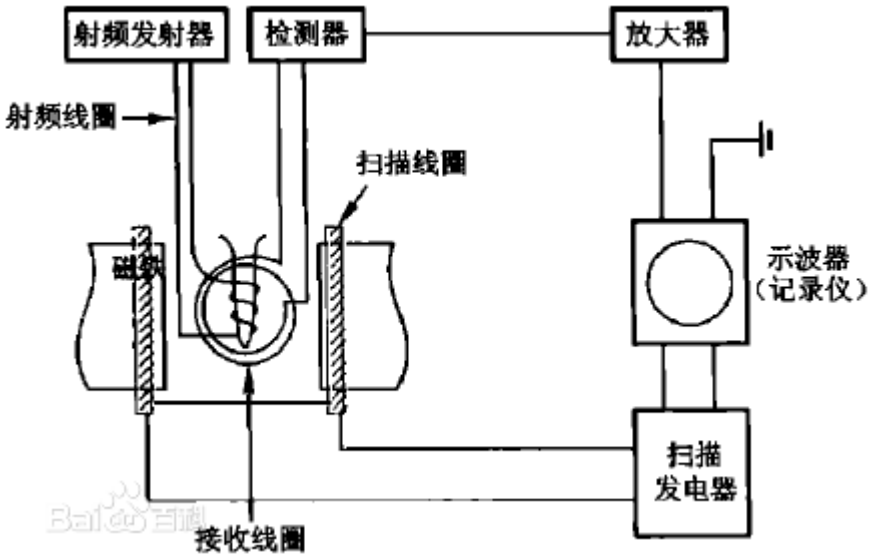
伪影(Artifacts)是指原本被扫描物体并不存在而在图像上却出现的各种形态的影像。伪影大致分为与患者有关和与机器有关的两类。

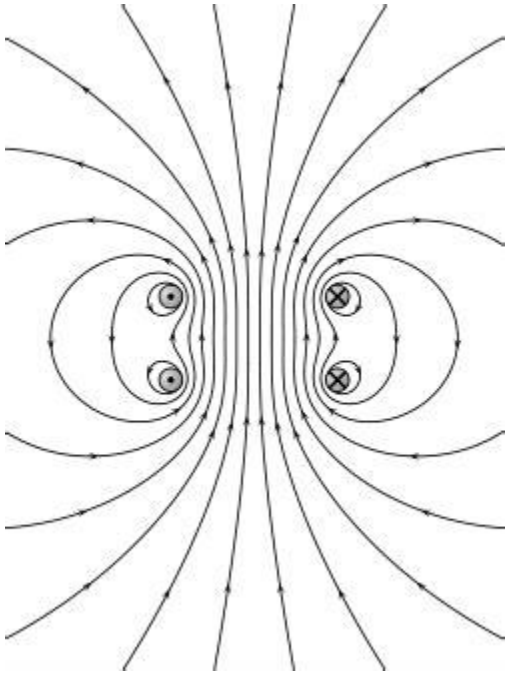
类卷褶伪影



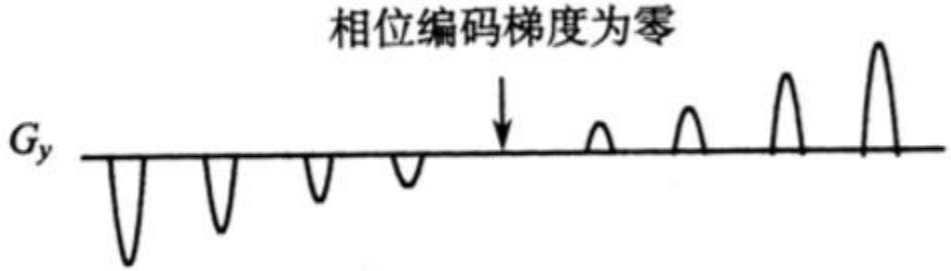
沿着相位编码方向移动样本的结果

亥姆霍兹线圈

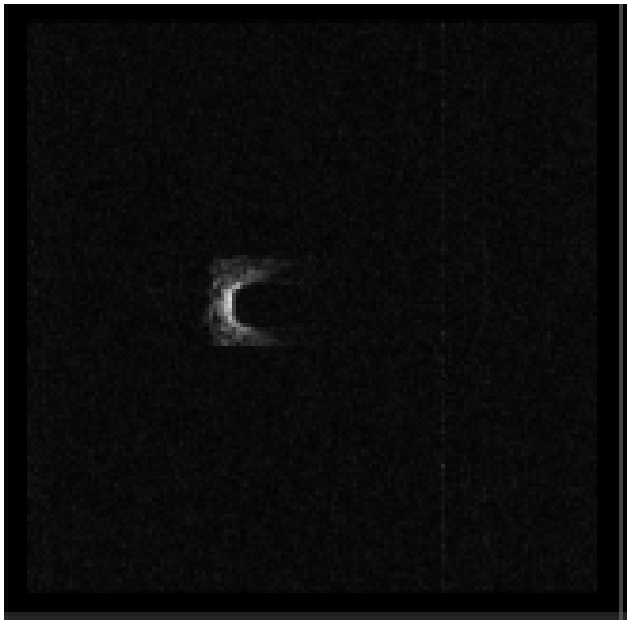


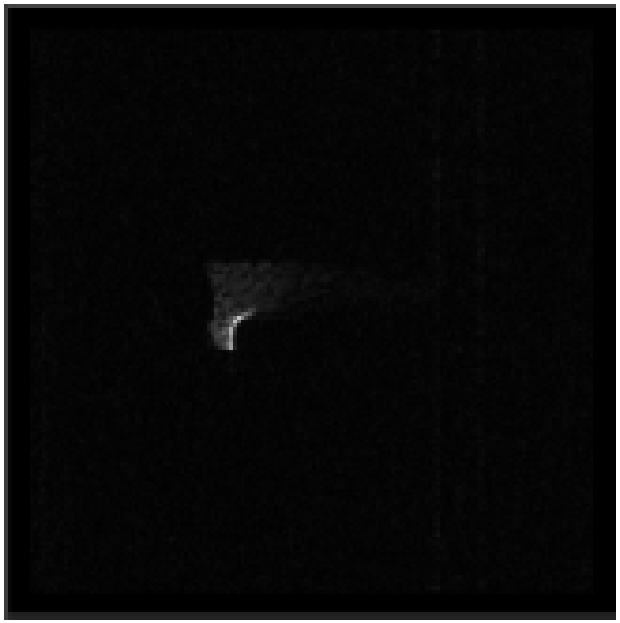


Y方向（相位编码）



金属伪影





样品中施加长约2mm左右的不锈钢丝所得图像

金属材料的磁化率

Material	χ_v / 10^{-6}	Material	χ_v / 10^{-6}
Bi	−164	Al	20.7
Au	−34	Zr	109
Ag	−24	Ti	170
Zn	−15.7	Ta	178
Cu	−9.63	Ti6Al4V alloy	179[12]
Water (37 ℃)	−9.05	Nb	237
α-Sn	−23	NiTi alloy	245
Human tissue	−11~−7	Pt	279
Si	−4.2	Pd	806
β-Sn	2.4	L605 alloy	960[13]
Mg	11.7	Stainless steel	3520~6700

Schenck J F. *The role of magnetic susceptibility in magnetic resonance imaging: MRI magnetic compatibility of the first and secondkinds [J]. Med. Phys., 1996, 23: 815*

参考文献

- S. MEIBooM and D. GIL *Modified Spin-Echo Method for Measuring Nuclear Relaxation Times*
- Schenck J F. *The role of magnetic susceptibility in magnetic resonance imaging: MRI magnetic compatibility of the first and second kinds [J]. Med. Phys., 1996, 23: 815*
- Zhou F Y, Qiu K J, Li H F, et al. *Screening on binary Zr-1X (X=Ti, Nb, Mo, Cu, Au, Pd, Ag, Ru, Hf and Bi) alloys with good in vitro cytocompatibility and magnetic resonance imaging compatibility [J]. Acta Biomater., 2013, 9: 9578*
- *Helmholtz coil Wikipedia entry*
- 魏利斌 *芝麻籽粒脂肪含量核磁共振无损快速测定方法的建立*
- 张进慧 *MRI常见伪影介绍*
- 任伊宾等 *MRI磁兼容合金研究. 金属学报, 2017,10:1323*
- Eric D. Black *Nuclear Magnetic Resonance (NMR)*

感谢您的聆听