

2021 Literature report I

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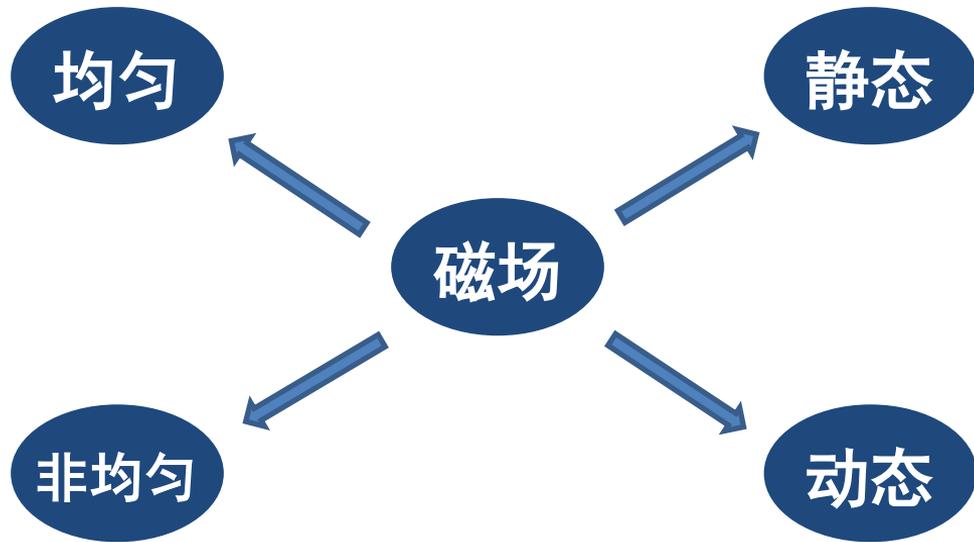
Cellular autofluorescence is magnetic field sensitive

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Introduction

磁场：是指传递实物间磁力作用的场，它的强弱和方向由磁感应强度 B 来表示，单位是特斯拉。



- 磁场被证明对人类健康有潜在威胁
- 很多动物可以感受到地磁场的变化
- 自由基机理

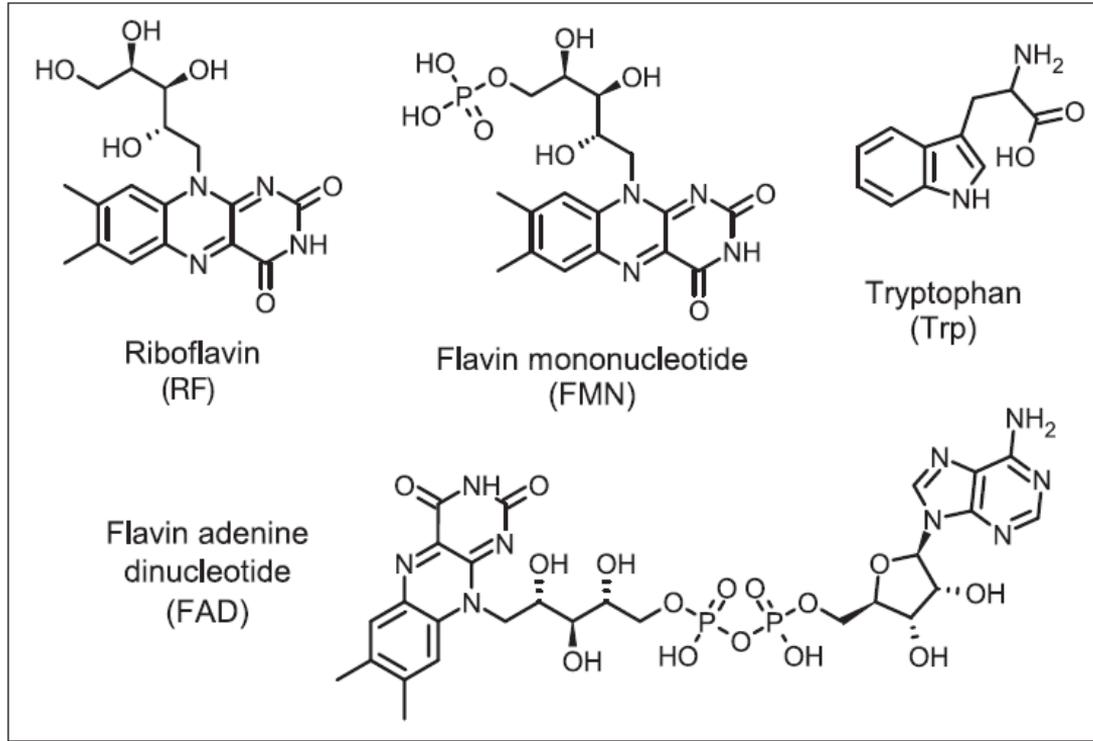
Introduction

Table 1. Reactive oxygen species (ROS) changes induced by static MFs (SMFs).

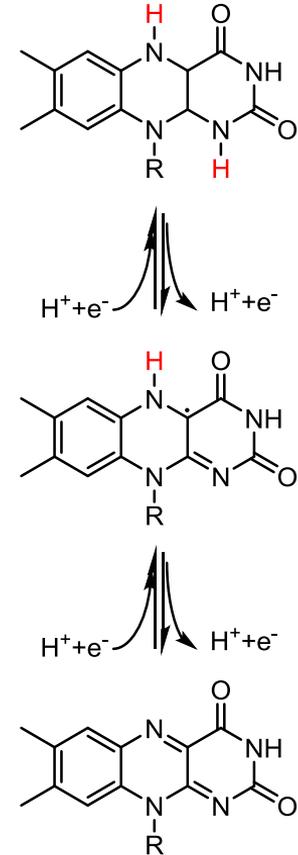
Species	Cell Lines/Organisms	SMF	Exposure Time	ROS Levels	Specific ROS	Refs.
Human cells	Human fibrosarcoma cancer cell line (HT1080)	Low level MF (0.2–2 μ T, GMF as control, 45–60 μ T)	6/12/24 h	Increased *	H ₂ O ₂	[26]
	Neuroblastoma cells (SH-SY5Y)	2.2 mT	24 h		•O ₂ ⁻	[27]
	Monocyte tumor cells (U937)	31.7–232.0 mT	2 h		H ₂ O ₂	[28]
	Peripheral blood neutrophils	6 mT	2 h		H ₂ O ₂	[29]
	Diploid embryonic lung fibroblast cell (WI-38)	60 mT (S pole)	45 min		H ₂ O ₂ /HOCl	[30]
	Leukemia cells (THP-1)	230–250 mT	18 h			[31]
Human cells	Human-hamster hybrid A(L) cells, mitochondria-deficient rho(0) A(L) cells, and double-strand break (DSB) repair-deficient XRS-5 cells	1.2 T	24 h	Increased		[32]
		8.5 T	3 h			[33]
					H ₂ O ₂	
Mouse cells	Embryonic stem (ES) cell (CGR8)-derived embryoid bodies and ES cell-derived Flk-1 ⁺ cardiovascular progenitor cells	0.2–5 mT	1 h/day, 10 days			[34]
	Normal liver cell line (NCTC 1469)	0.4 T	1/24/48/72 h			[35]
	Embryonic Stem Cells	1/10 mT	8 h/day, 17 days			[36]
Bovine cells	Bovine pulmonary artery endothelial cells (PAEC)	Low level MF (0.2–2 μ T, GMF as control, 45–60 μ T)	8/24 h	Increased *		[26]
Plant	Soybean seeds	150–200 mT	1 h	Increased	•O ₂ ⁻ / •OH/H ₂ O ₂	[37]
Human cells	Peripheral blood neutrophils	60 mT	15 min	Decreased	H ₂ O ₂ /HOCl	[30]
	Bronchial epithelial cells (A549)	389 mT	30 min	Decreased		[38]
Mouse cells	Primary mouse skeletal muscle cell	<3 μ T (GMF as control, ~50 μ T)	3 days	RWPE-induced ROS Decreased *	H ₂ O ₂	[39]
Human cells	Pancreatic cancer cell line (AsPC-1)	Low level MF (0.2–2 μ T, GMF as control, 45–60 μ T)	12/24 h		H ₂ O ₂	[26]
	Peripheral blood neutrophils	60 mT	30 min 45 min (N pole)		H ₂ O ₂ /HOCl	[30]
	Diploid embryonic lung fibroblast cell (WI-38)	230–250 mT	5 days	No change		[31]
	Lung fibroblasts (MRC-5)	370 mT	1 h/day, for 4 days		H ₂ O ₂	[40]
Bacteria	Bronchial epithelial cells (A549)	389 mT				[38]
	<i>E. coli</i> and <i>S. aureus</i>	100 mT	30 min			[41]

Grey color indicates that SMFs increase ROS levels. Blue color indicates that SMFs decrease ROS levels, and green color indicates SMFs do not affect ROS levels. "Increased **" means indirect evidence of SMF-induced ROS increase, because the study showed that H₂O₂ decreased after GMF shielding. "Decreased **" means indirect evidence of SMF-induced ROS decrease, because the study showed H₂O₂ increased after GMF shielding.

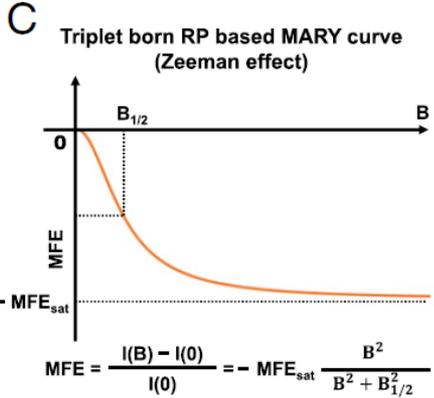
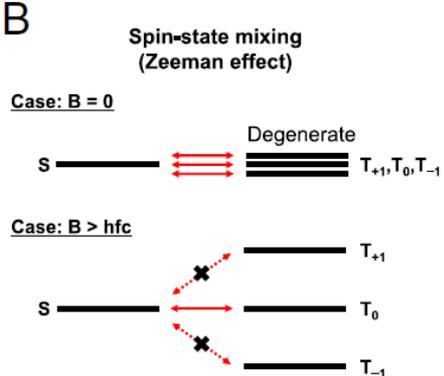
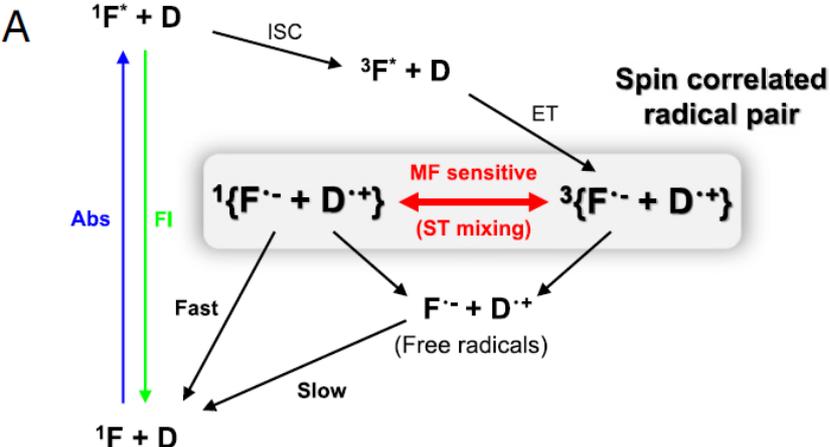
Principle



Scheme 1. Chemical structures of RF, FMN, FAD, and Trp.



Principle

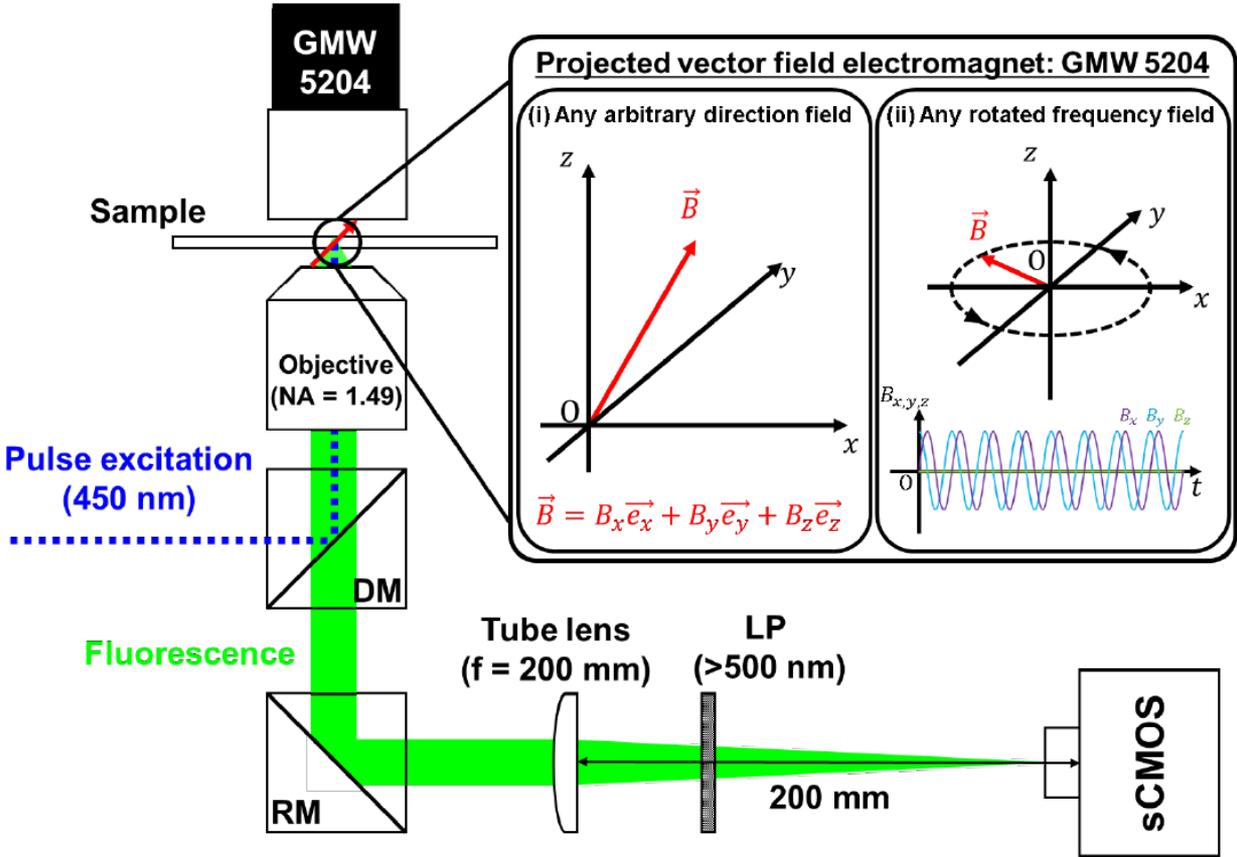


- 塞曼效应：原子在外磁场中发光谱线发生分裂且偏振的现象

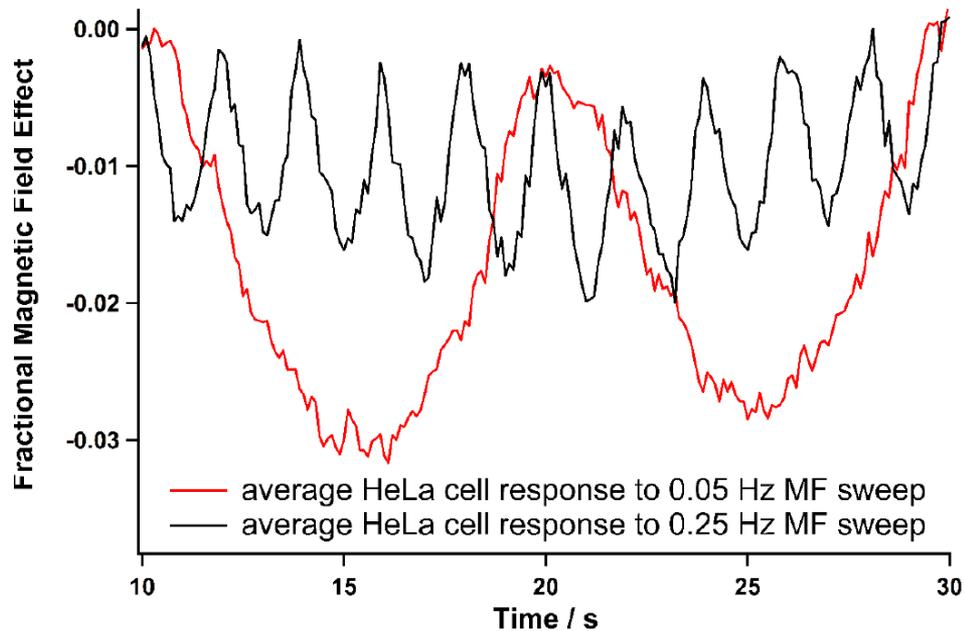
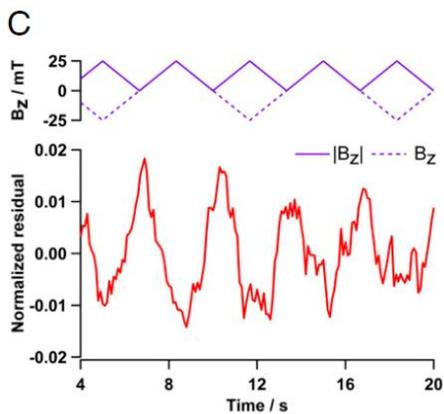
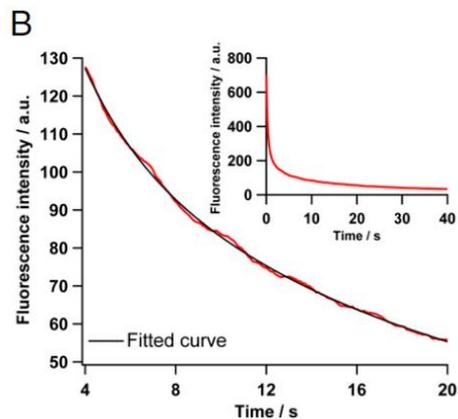
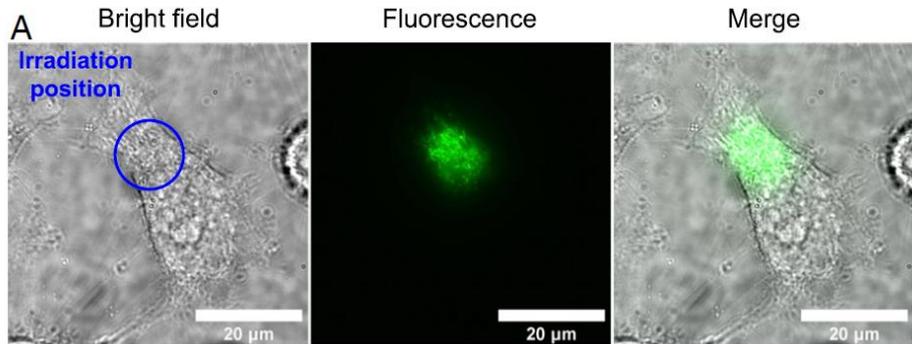
- $E_{Zeeman} = +g \mu_B B_0 M_s$

- 荧光会随着外加磁场的增强而减弱

Principle



Characterization



Characterization

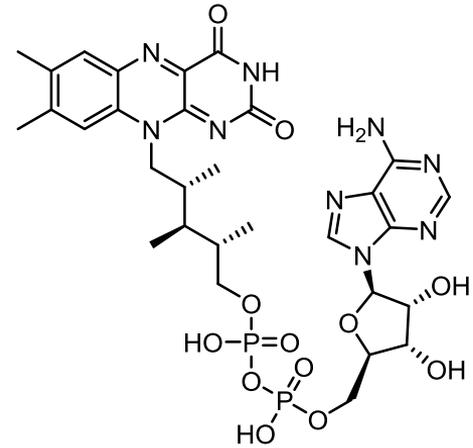
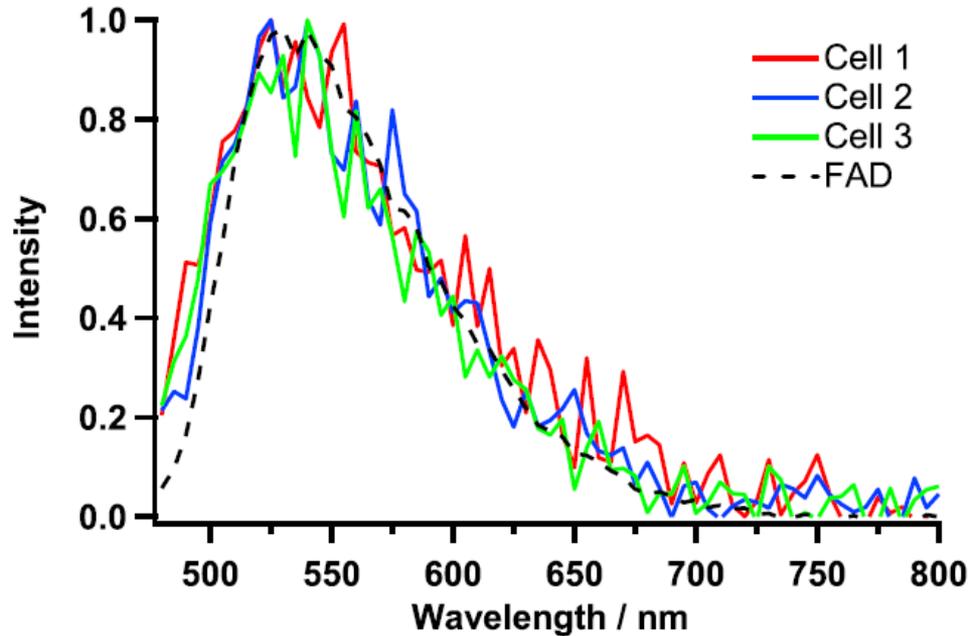
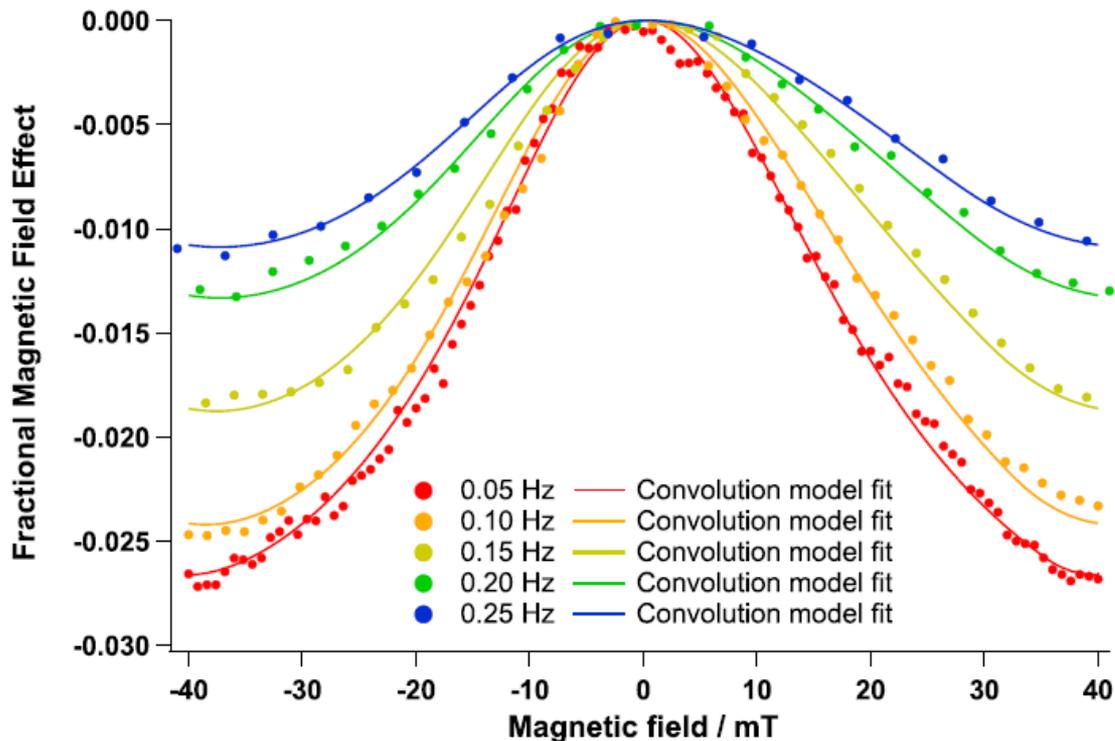


Fig. 3. Fluorescence spectra of single HeLa cells under 450 nm excitation in our microscope. Solid lines show the fluorescence spectra of auto-fluorescence from each individual HeLa cell. The dotted line shows the fluorescence spectrum of 10 μ M FAD in PBS buffer at pH 7.4. The intensity is normalized to the maximum intensity. Scan range = 480 to 800 nm; scan interval = 5 nm.

Characterization



- 测得的 $B_{1/2}$ 值是 18 ± 0.5 mT
- 溶液中测定值为4到8 mT
- 与纯化蛋白结合后的 $B_{1/2}$ 值介于两者之间

Summary

- 通过荧光变化直接观察自由基对反应对磁场的响应
- 可以做到对动态磁场响应的实时观测
- 确定了荧光响应物种为黄素类物质