



2021 Literature report I

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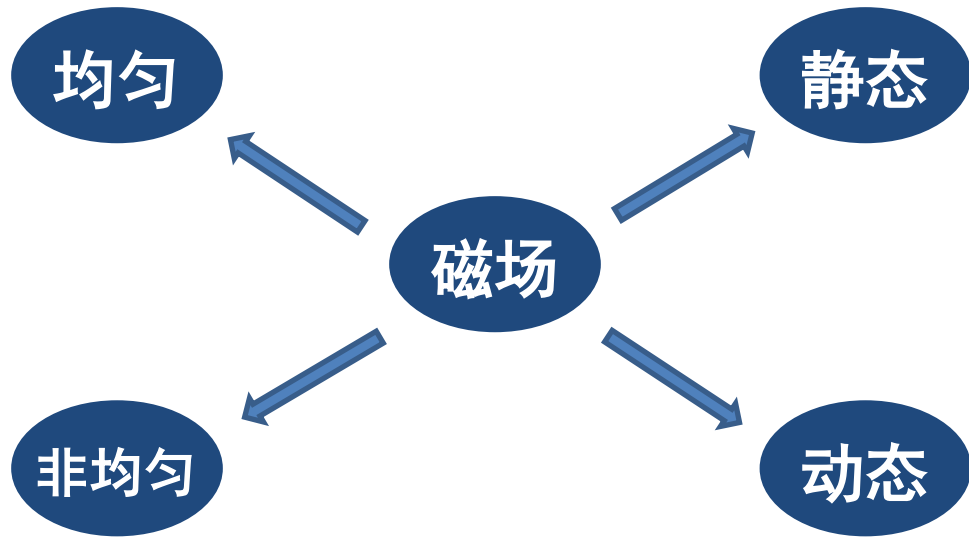
Cellular autofluorescence is magnetic field sensitive

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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

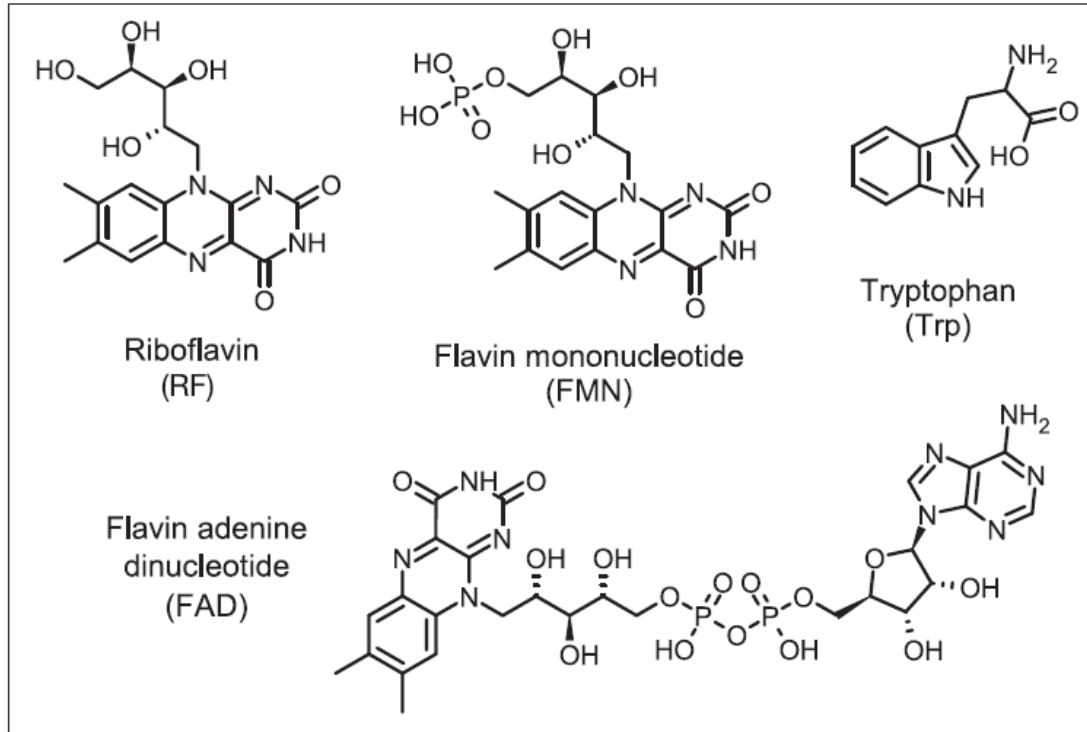
Introduction

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

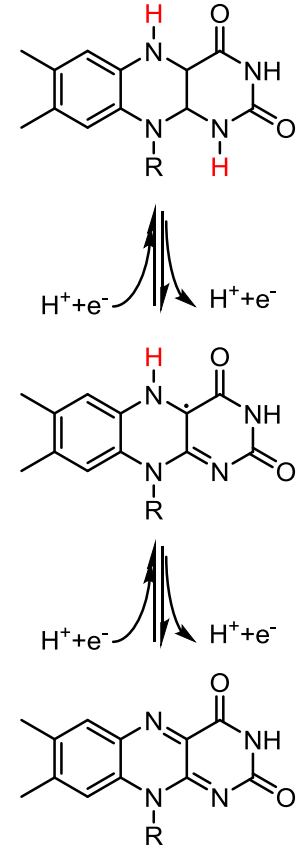
Species	Cell Lines/Organisms	SMF	Exposure Time	ROS Levels	Specific ROS	Refs.
Human cells	Human fibrosarcoma cancer cell line (HT1080)	Low level MF (0.2–2 μ T, GMF as control, 45–60 μ T)	6/12/24 h	Increased *	H ₂ O ₂	[26]
	Neuroblastoma cells (SH-SY5Y)	2.2 mT 31.7–232.0 mT	24 h		H ₂ O ₂	[27]
	Monocyte tumor cells (U937)	6 mT	2 h		•O ₂ ⁻	[28]
	Peripheral blood neutrophils	60 mT (S pole)	45 min		H ₂ O ₂	[29]
	Diploid embryonic lung fibroblast cell (WI-38)	230–250 mT	18 h		H ₂ O ₂ /HOCl	[30]
	Leukemia cells (THP-1) 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 8.5 T	24 h 3 h	Increased		[31] [32] [33]
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		H ₂ O ₂	[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.

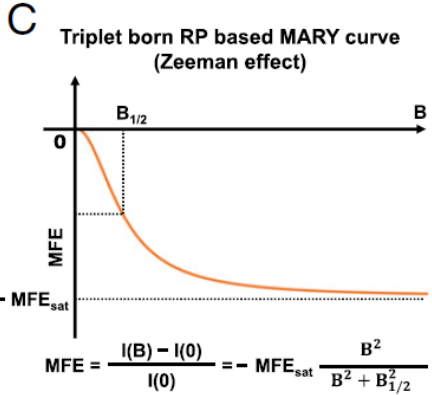
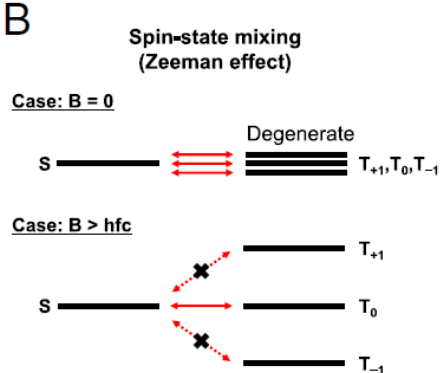
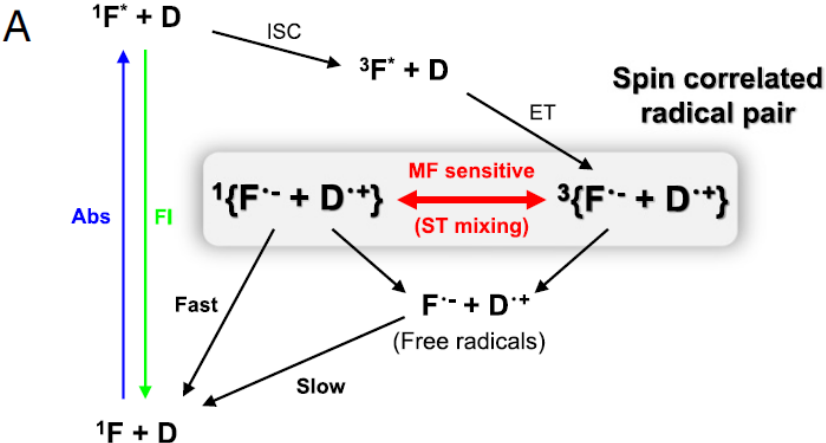
Principle



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



Principle

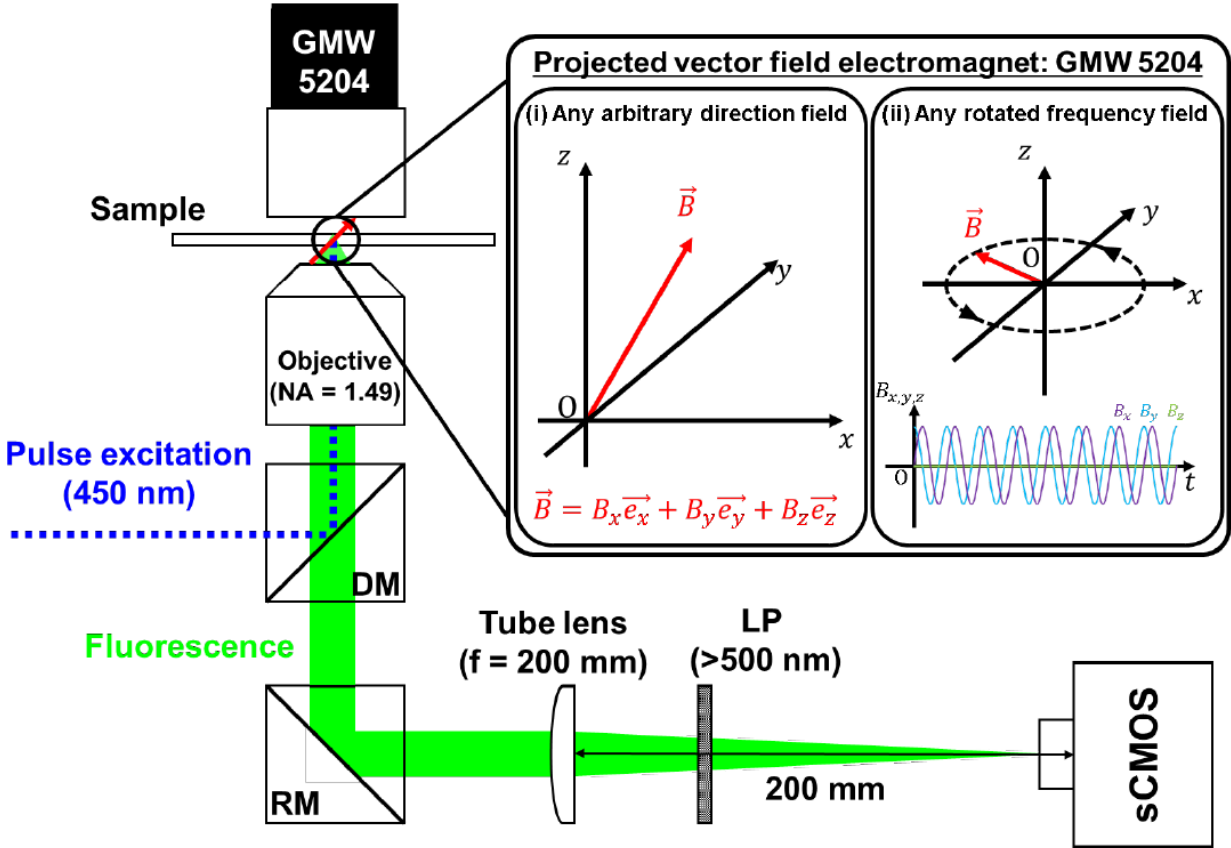


- 塞曼效应：原子在外磁场中发光谱线发生分裂且偏振的现象

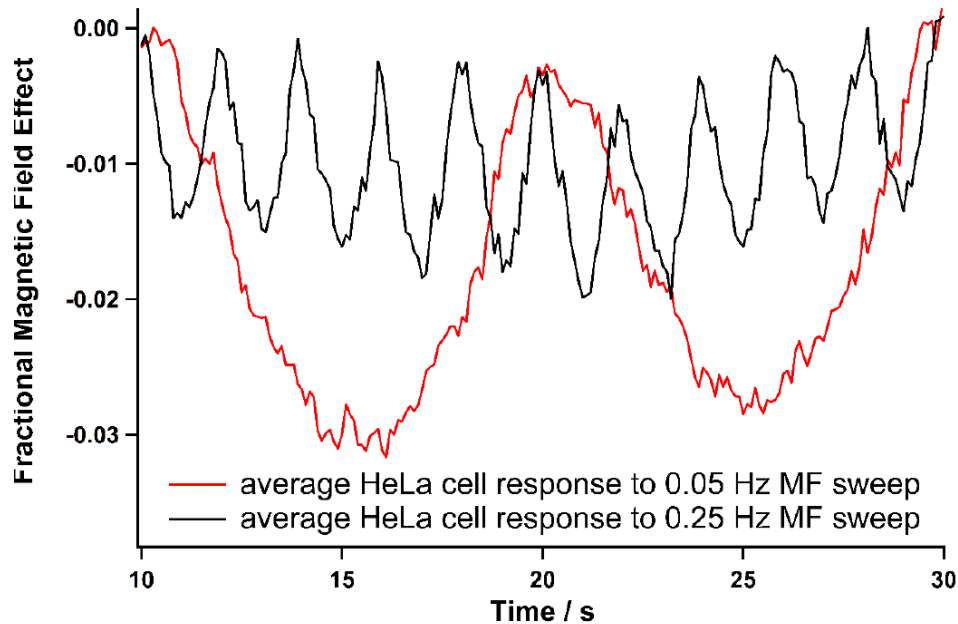
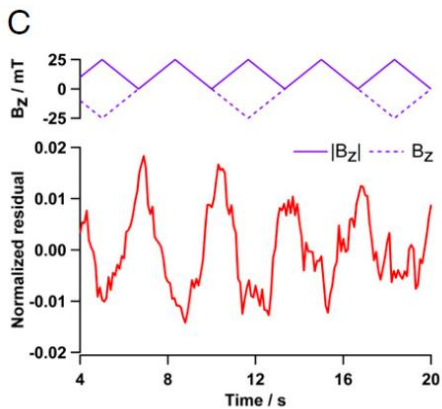
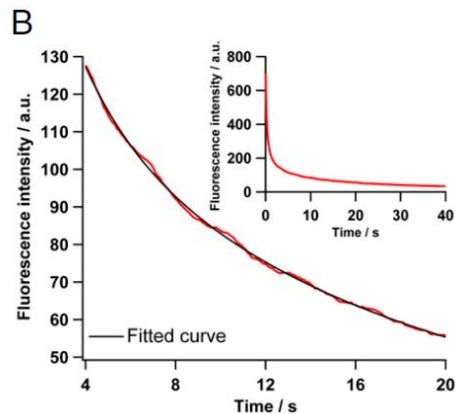
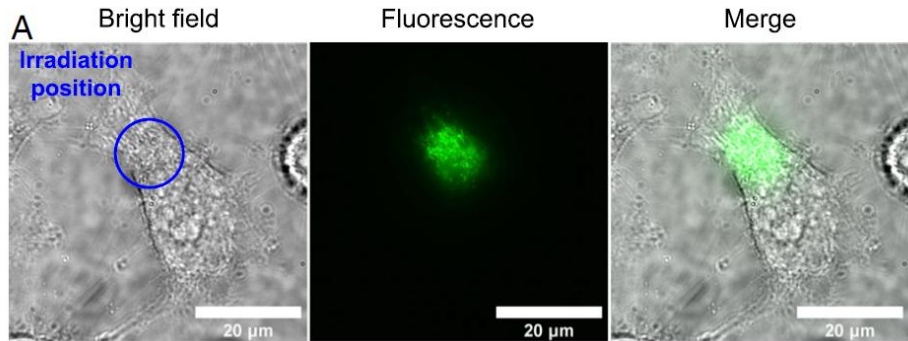
- $E_{Zeeman} = +g \mu_B B_0 M_s$

- 荧光会随着外加磁场的增强而减弱

Principle



Characterization



Characterization

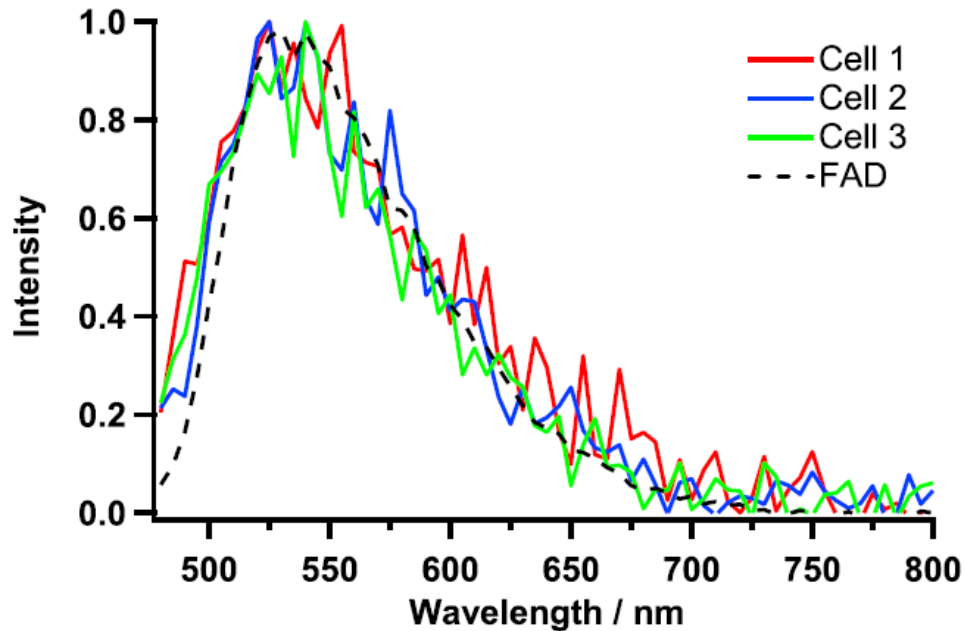
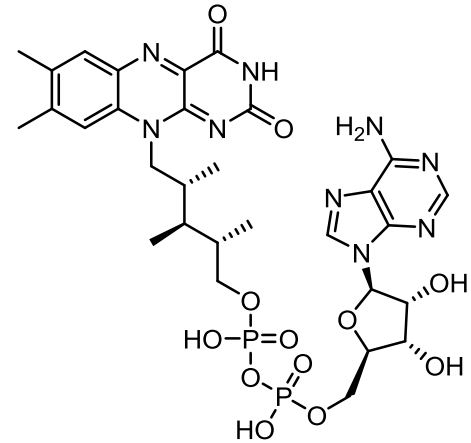
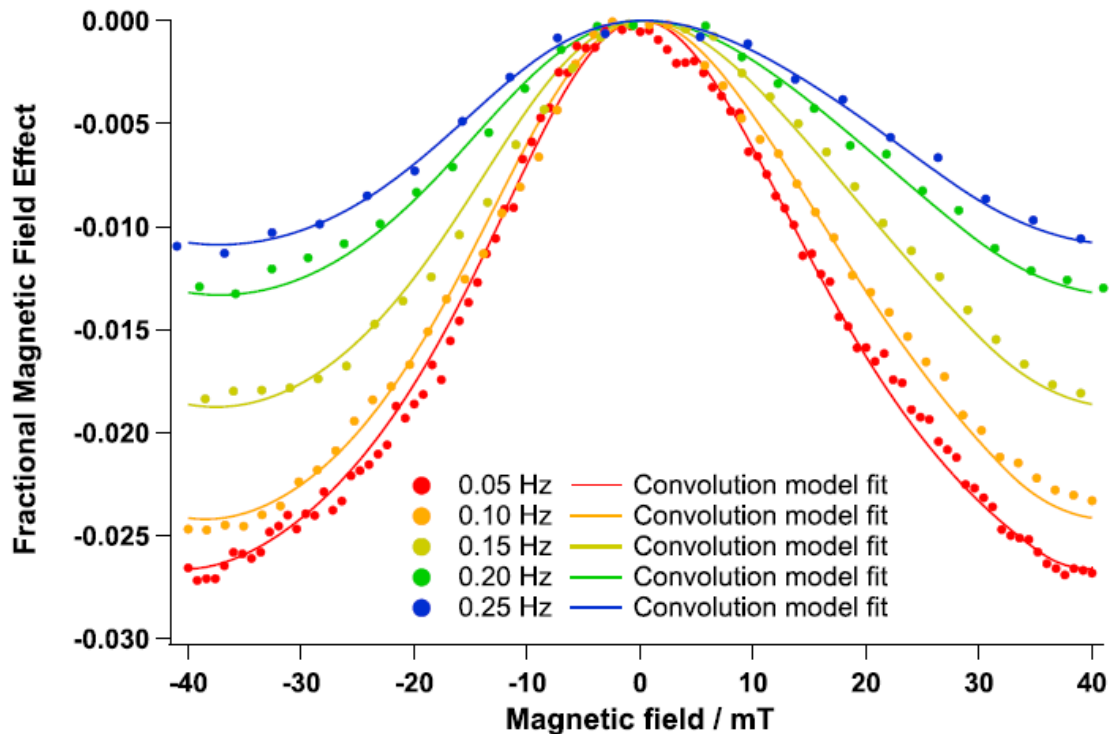


Fig. 3. Fluorescence spectra of single HeLa cells under 450 nm excitation in our microscope. Solid lines show the fluorescence spectra of auto-fluorescence from each individual HeLa cell. The dotted line shows the fluorescence spectrum of 10 μM FAD in PBS buffer at pH 7.4. The intensity is normalized 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