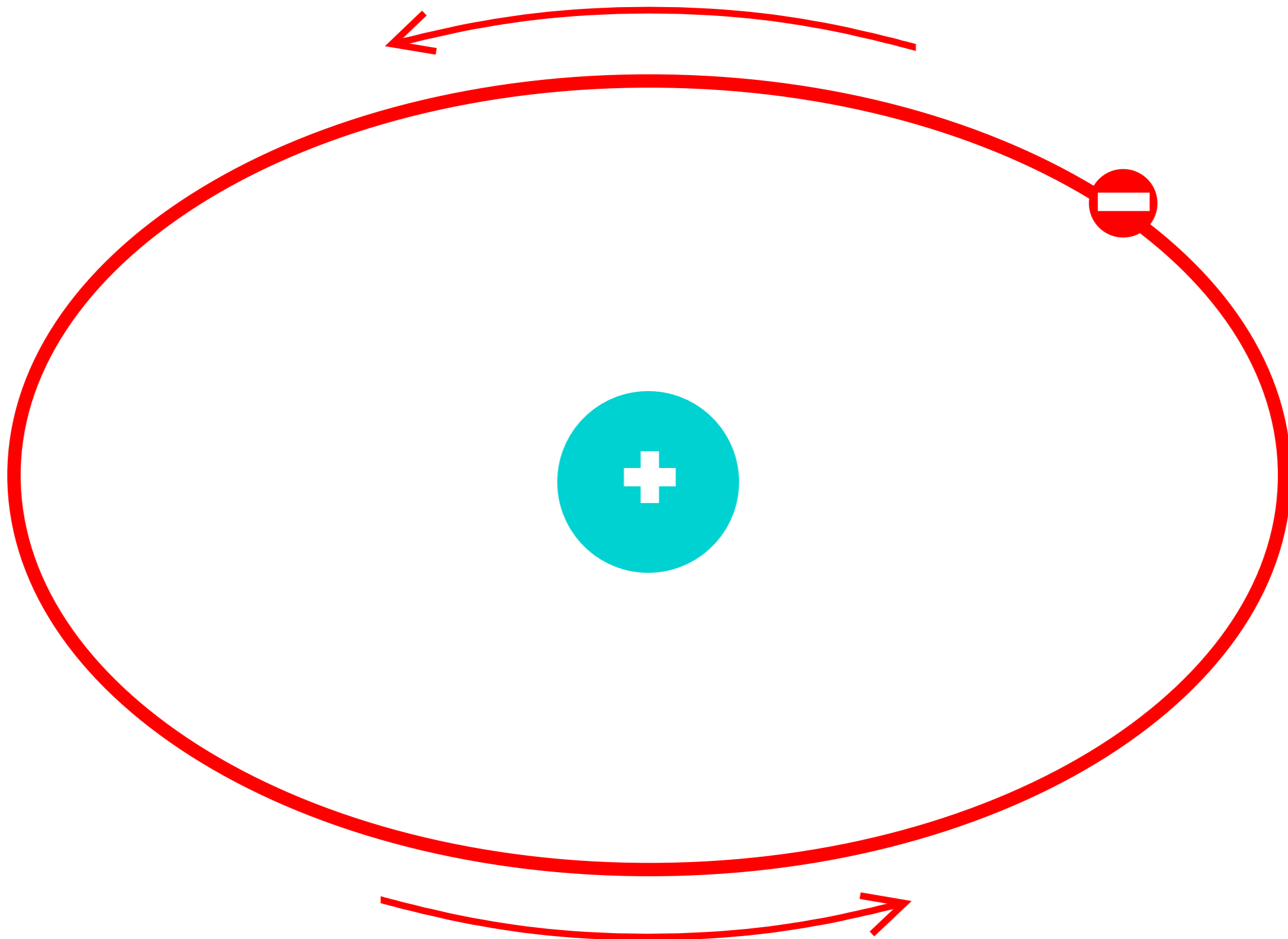
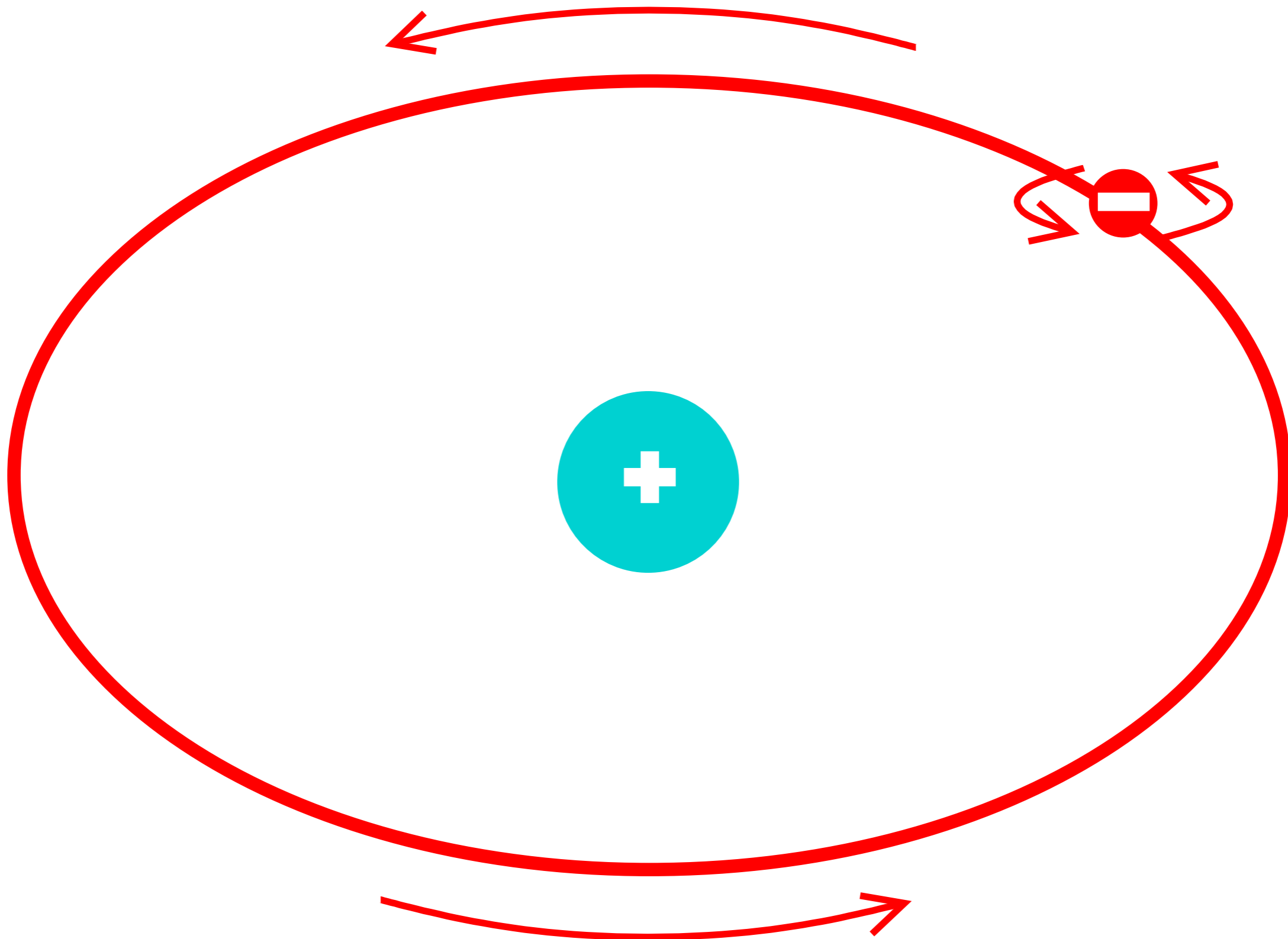


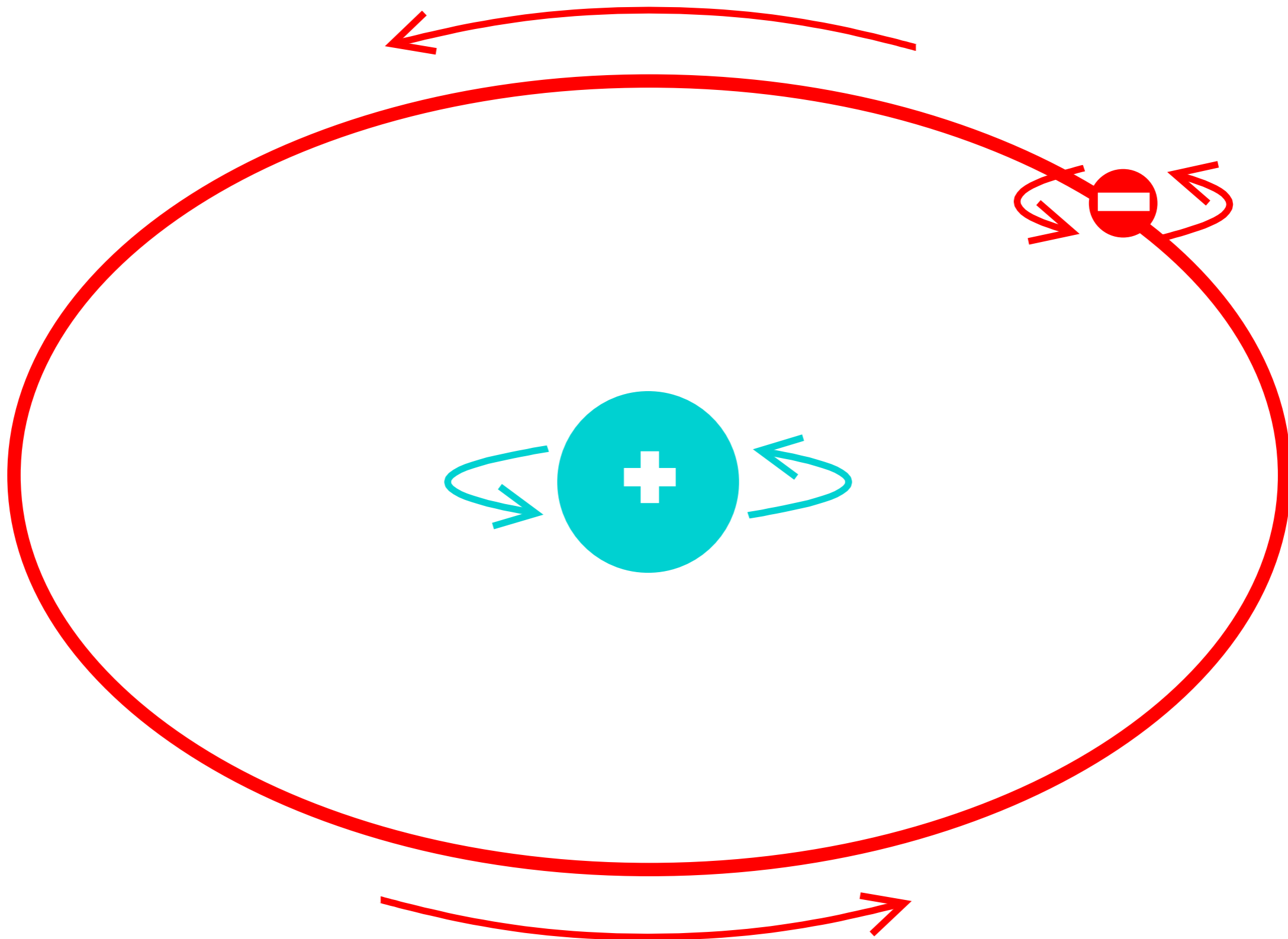
NMR

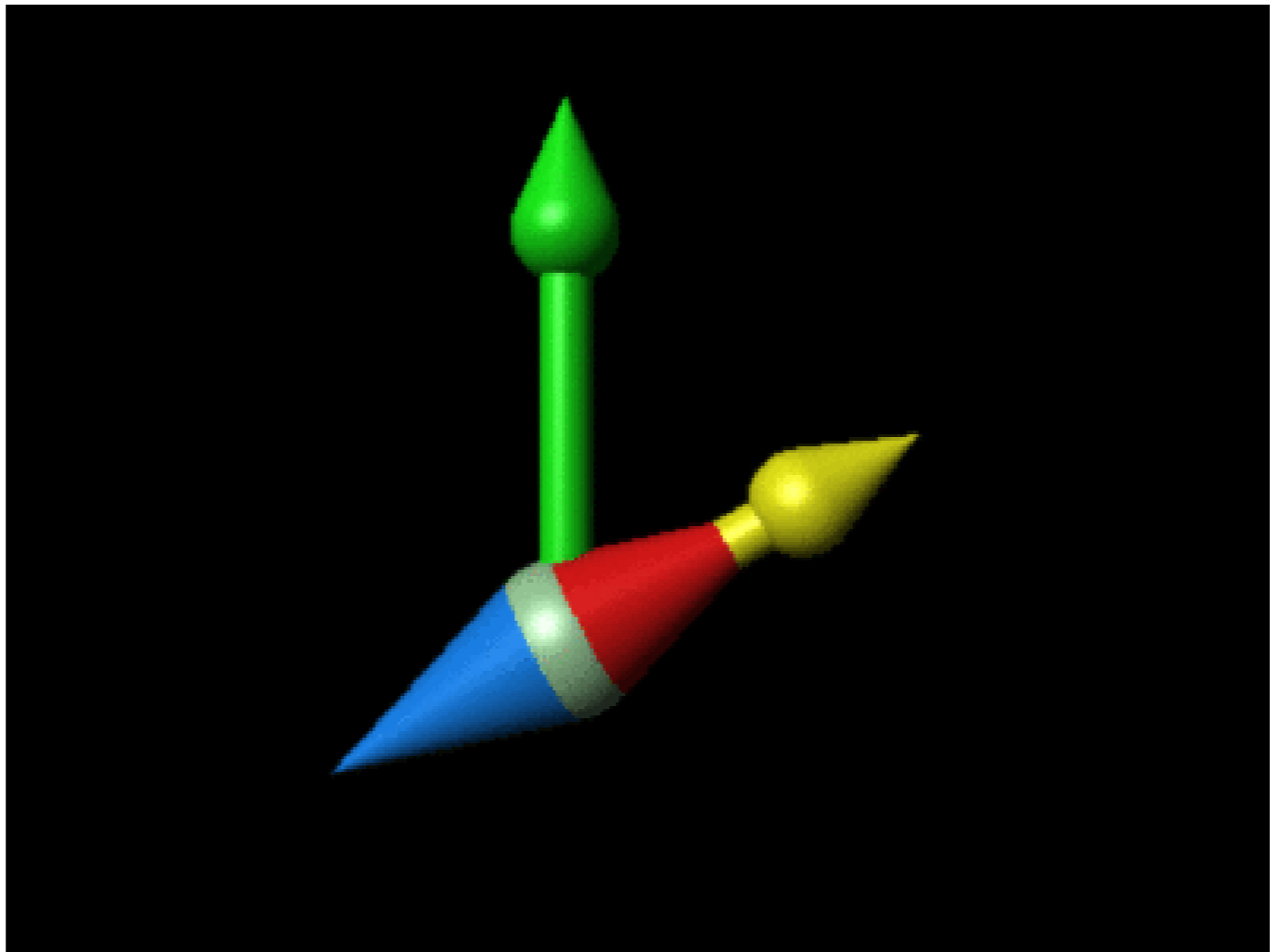
NUKLEÁRNÍ MAGNETICKÁ REZONANCE

doc. Mgr. Lukáš Žídek, Ph.D.

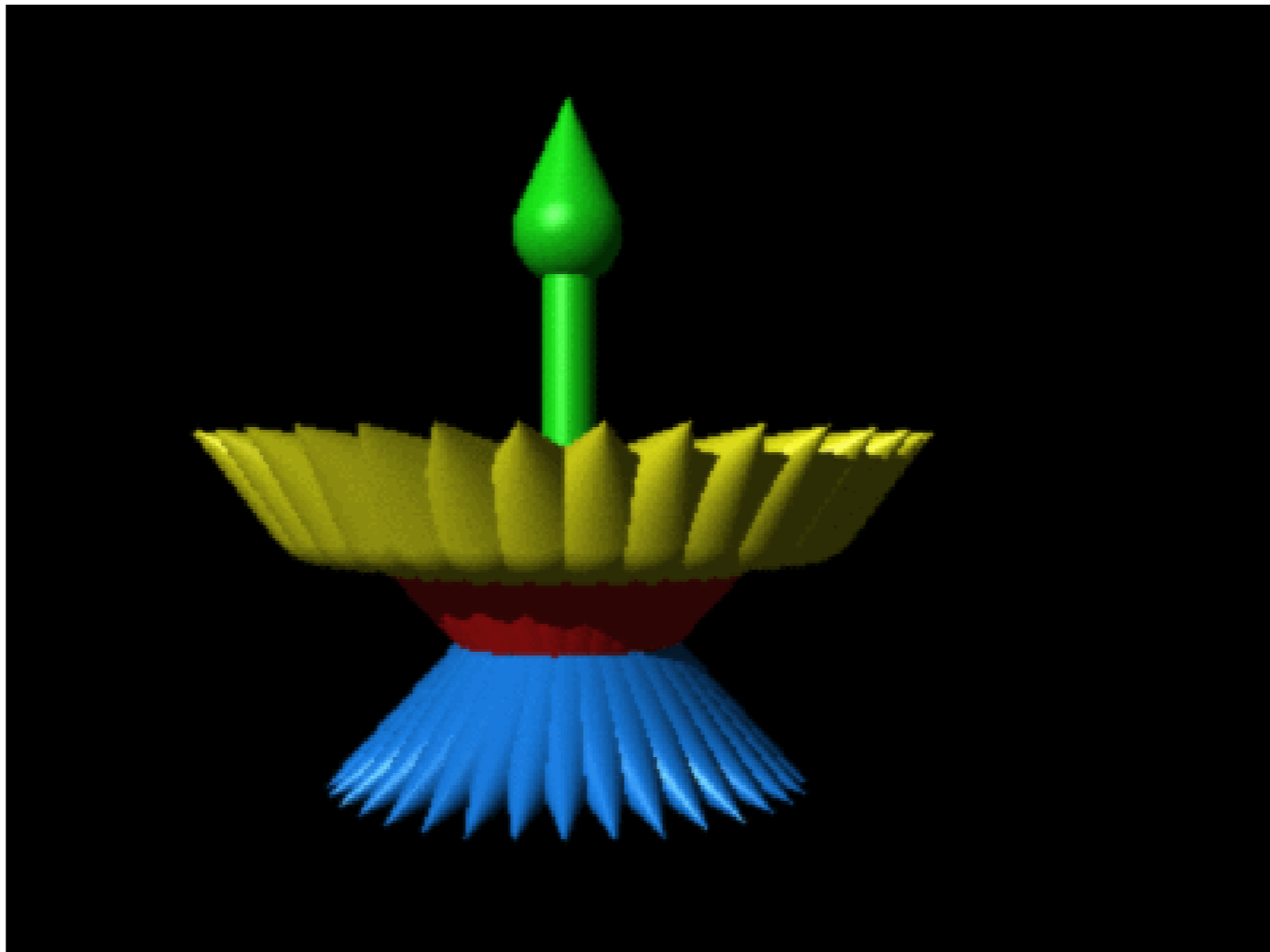








Jedno jádro v magnetickém poli



Termodynamická rovnováha

E

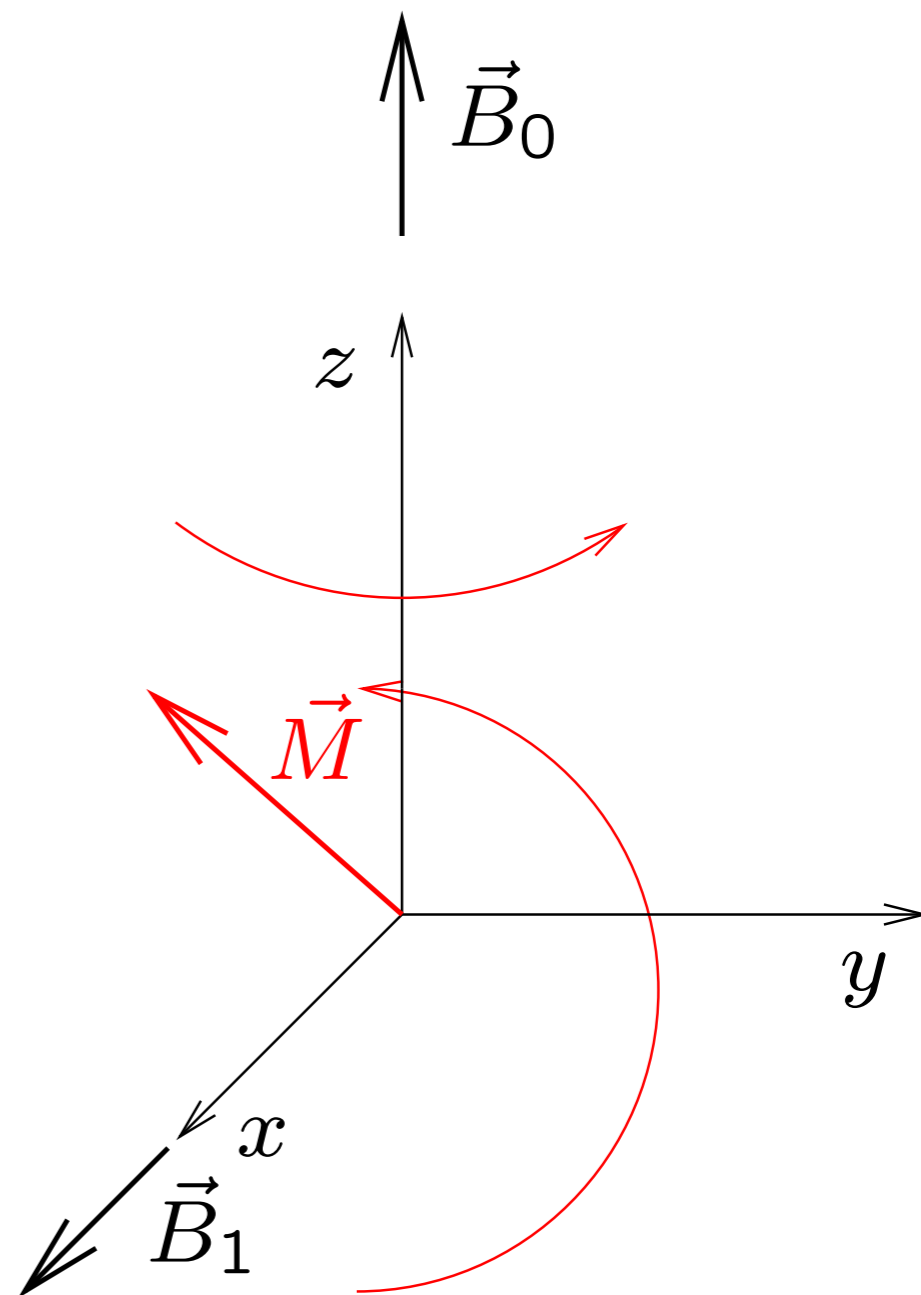
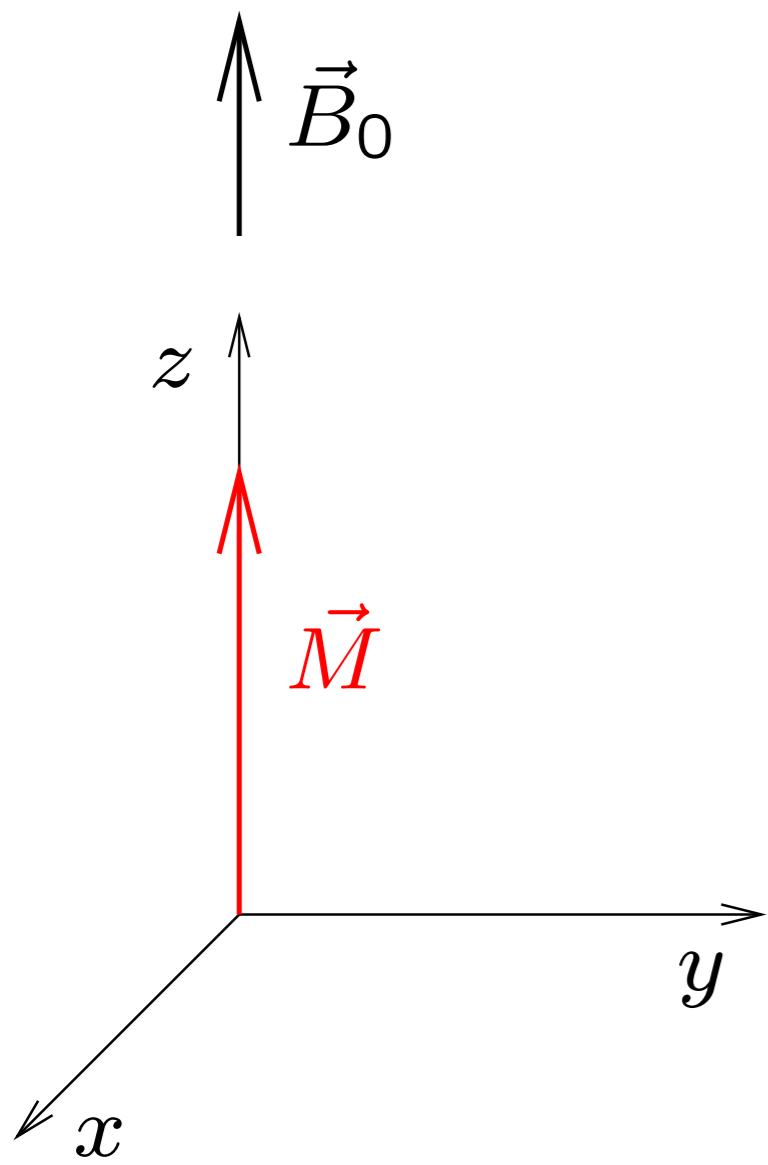
$B_0 = 11.75 \text{ T}$

$N_{\downarrow} = 499\,980\,000\,000\,000\,000\,000$

$f = 500 \text{ MHz}$

$\frac{N_{\uparrow}}{N_{\downarrow}} = 1.00008$

$N_{\uparrow} = 500\,020\,000\,000\,000\,000\,000$

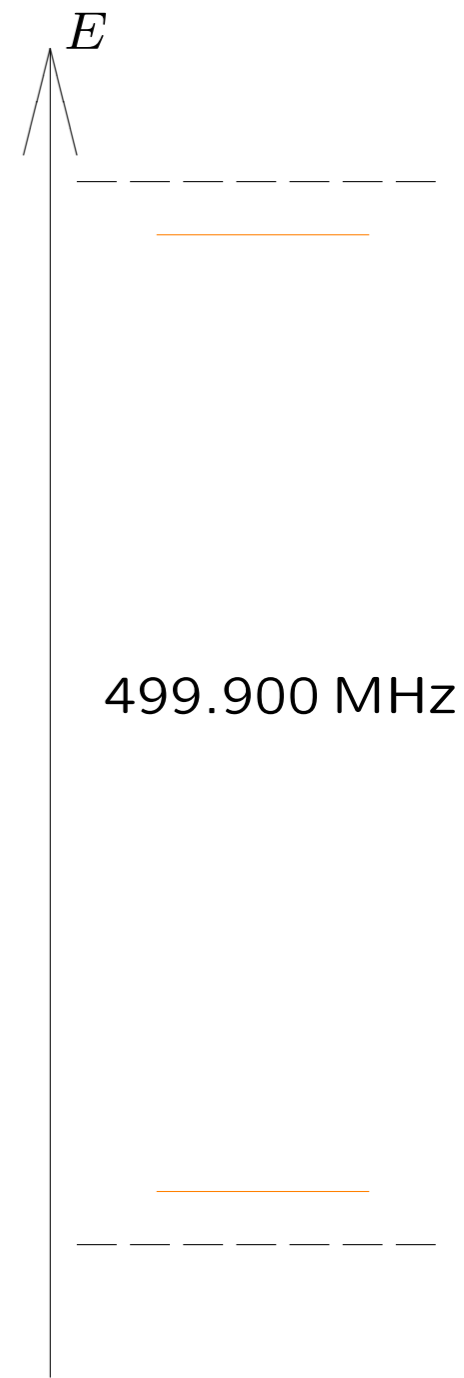
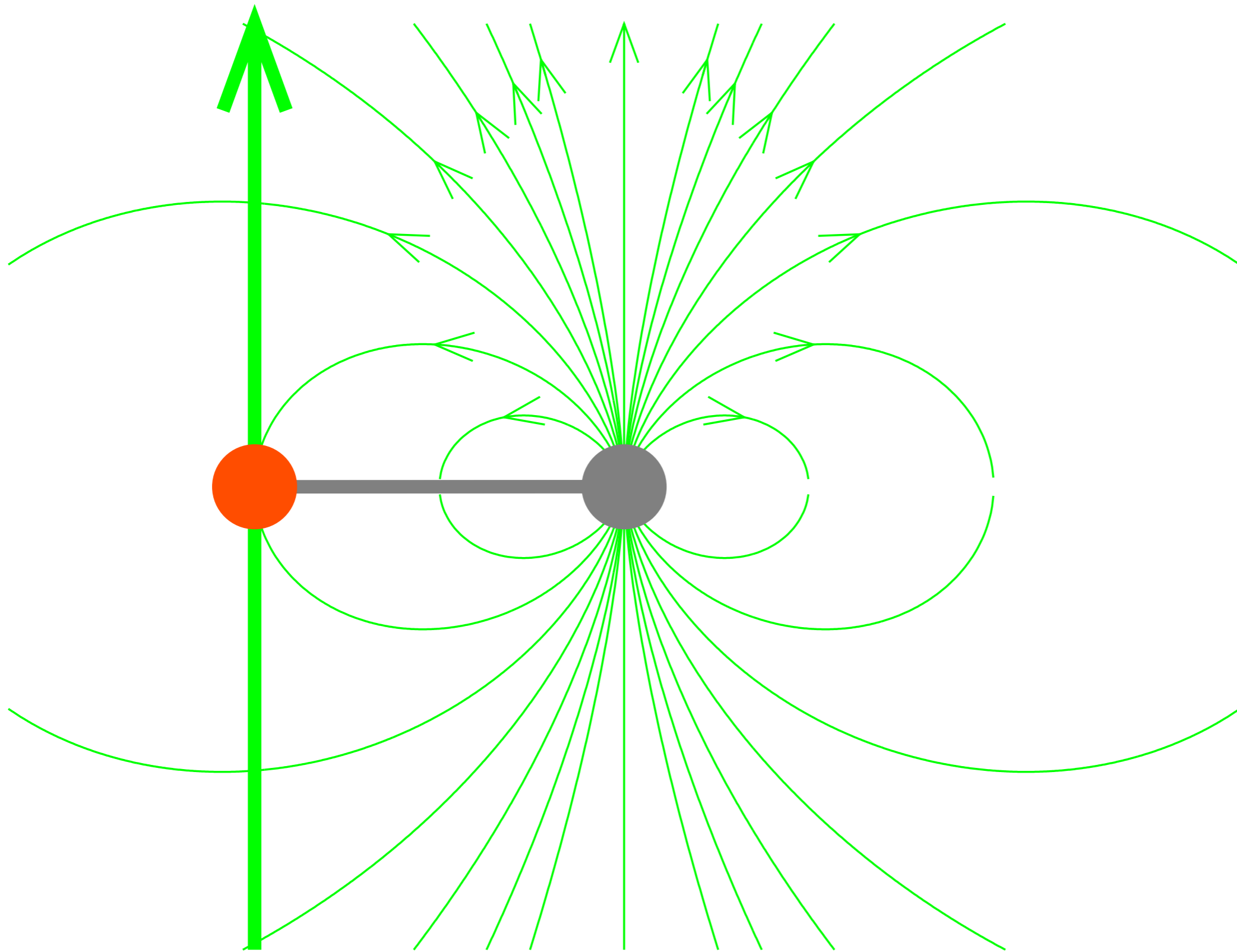


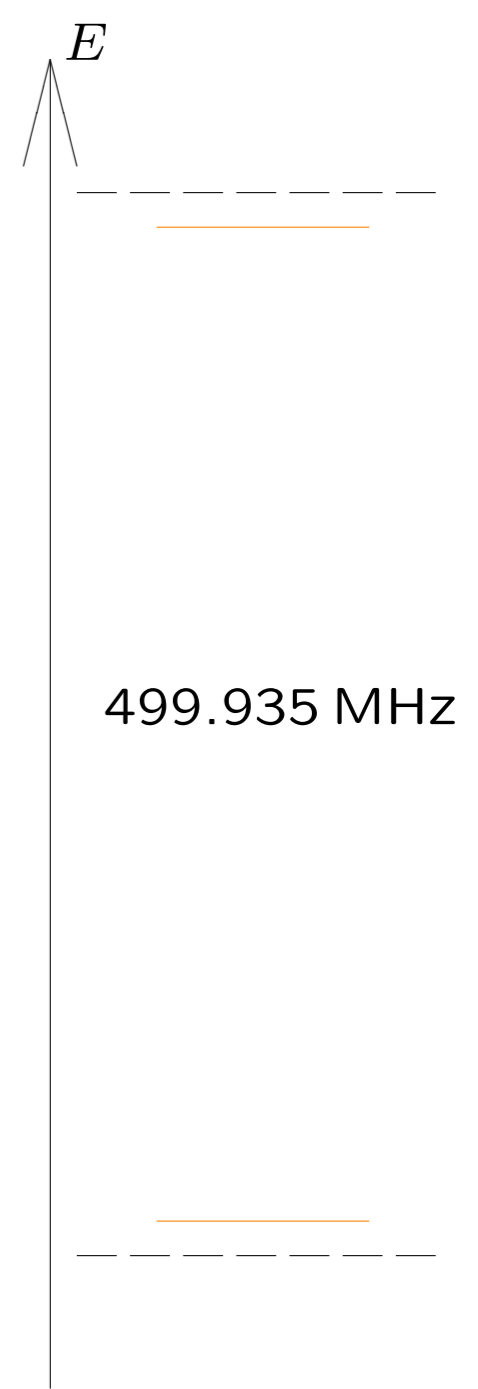
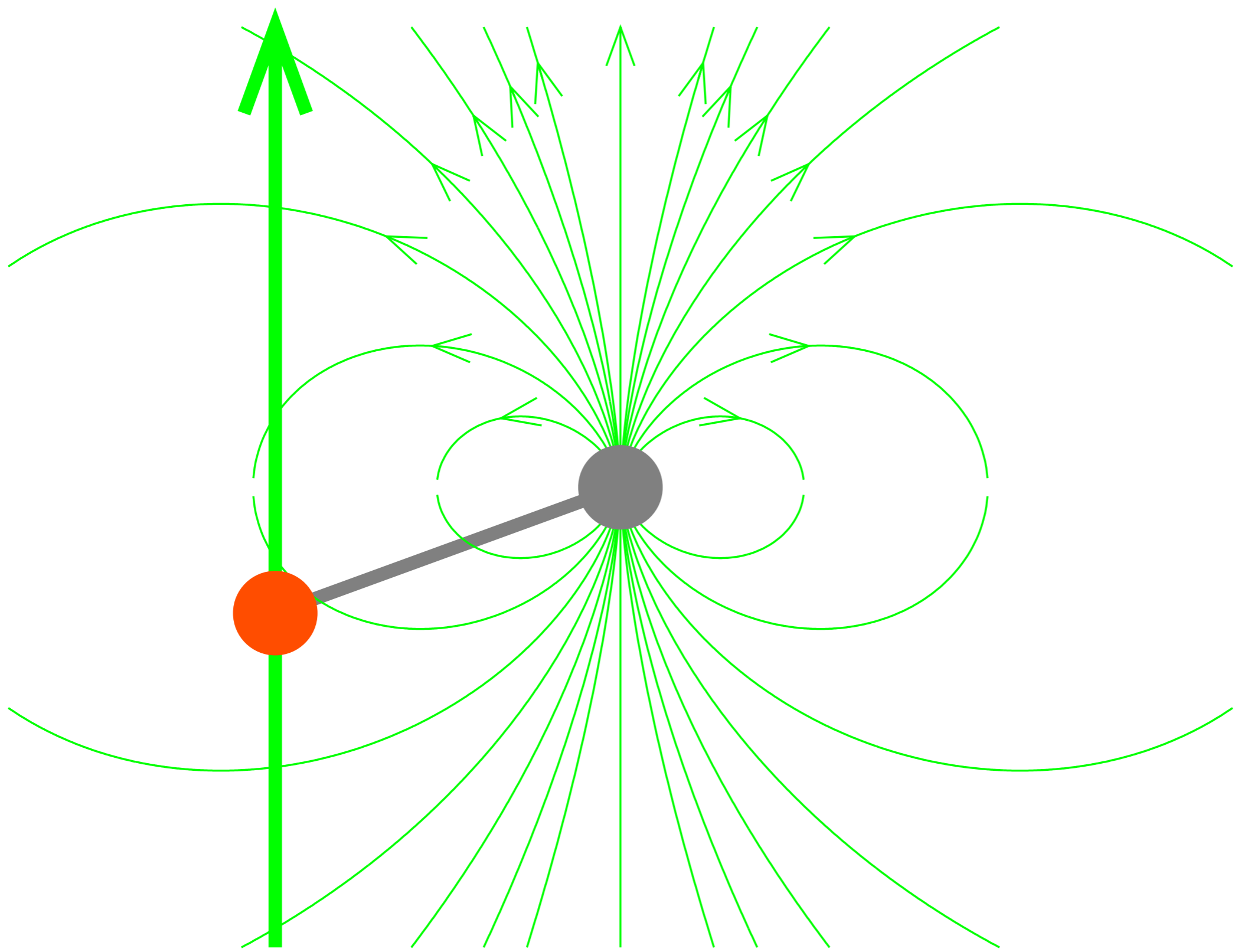
Experiment

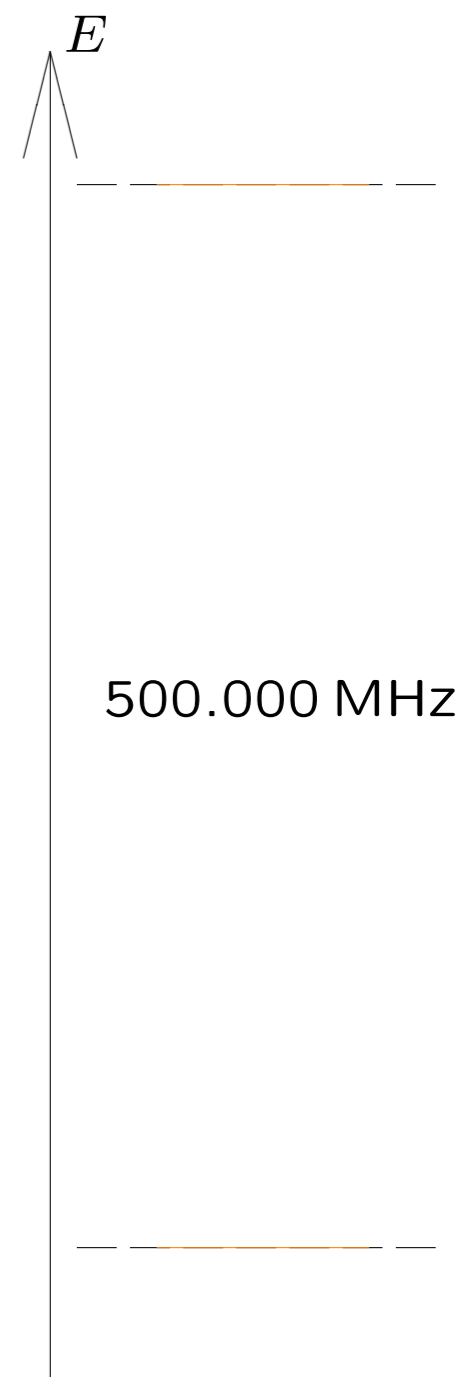
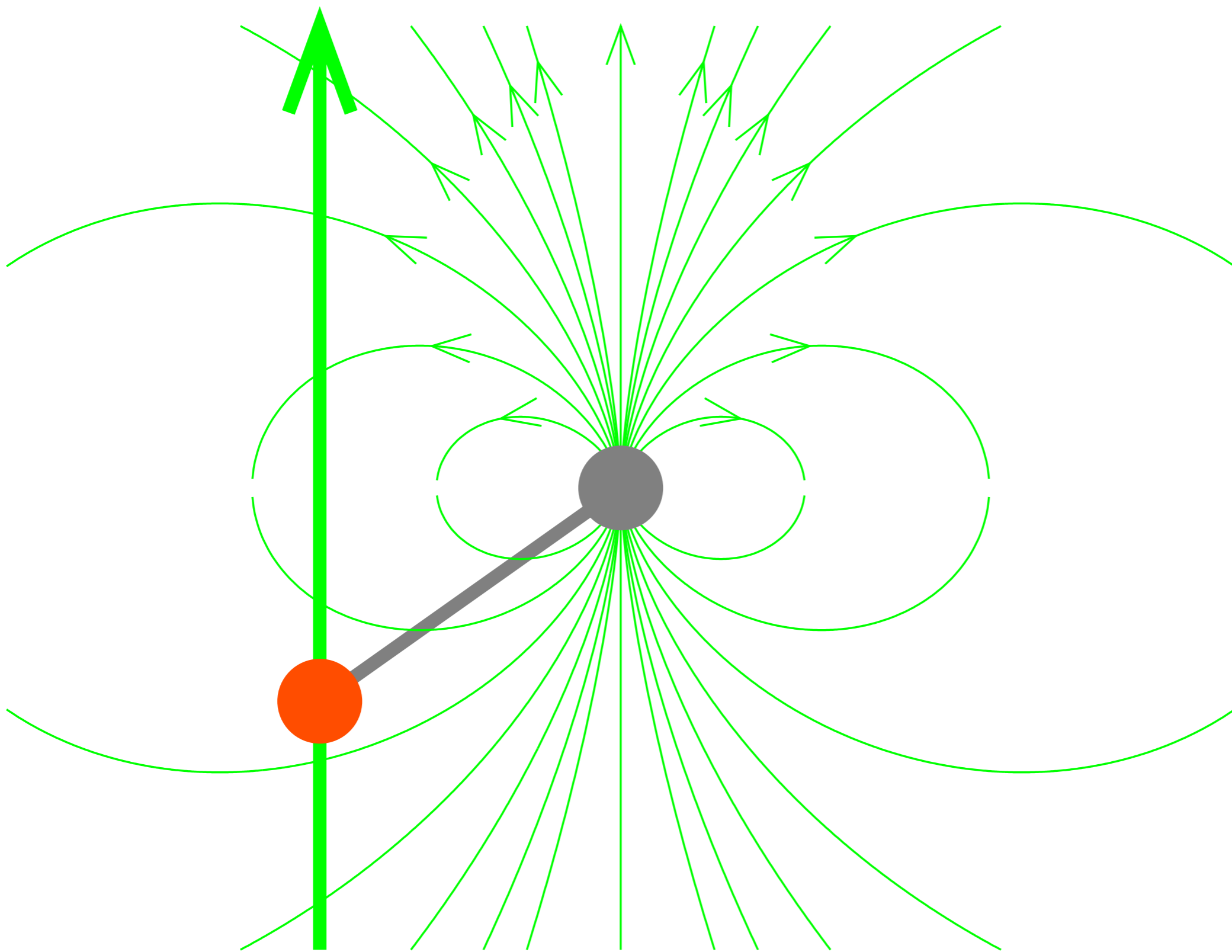
- Příjímač vypnut, vysílač zapnut: **Excitace**
- Příjímač zapnut, vysílač vypnut: **Detekce**
- Příjímač vypnut, vysílač vypnut: **Relaxace**

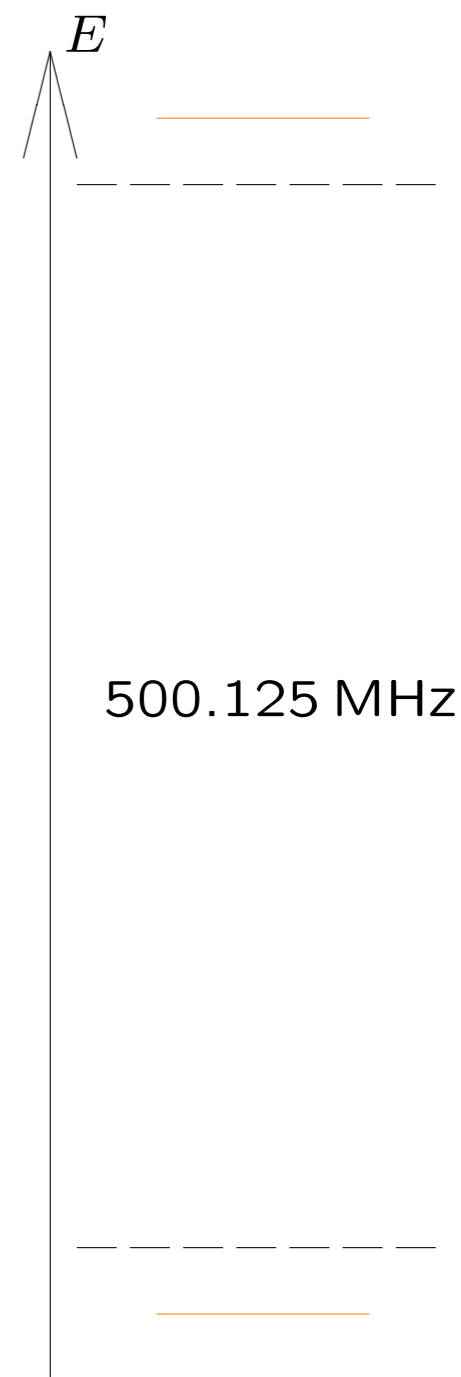
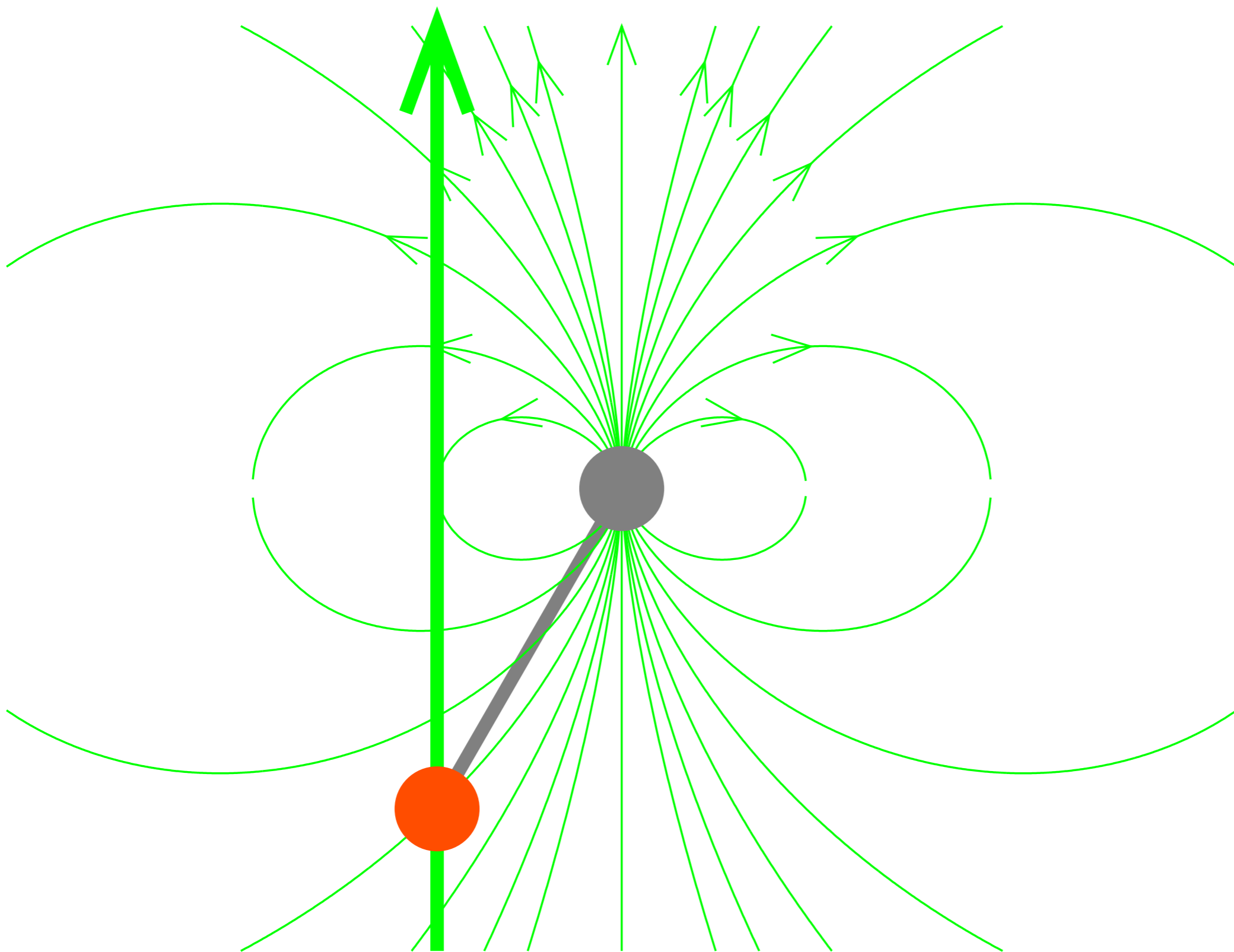
Magnetická pole v molekule:

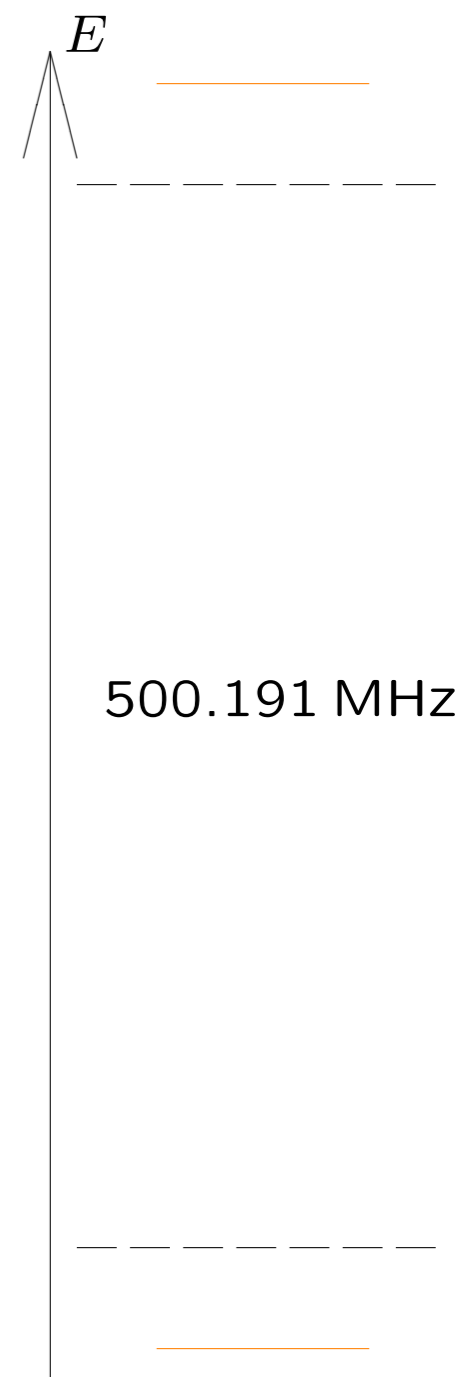
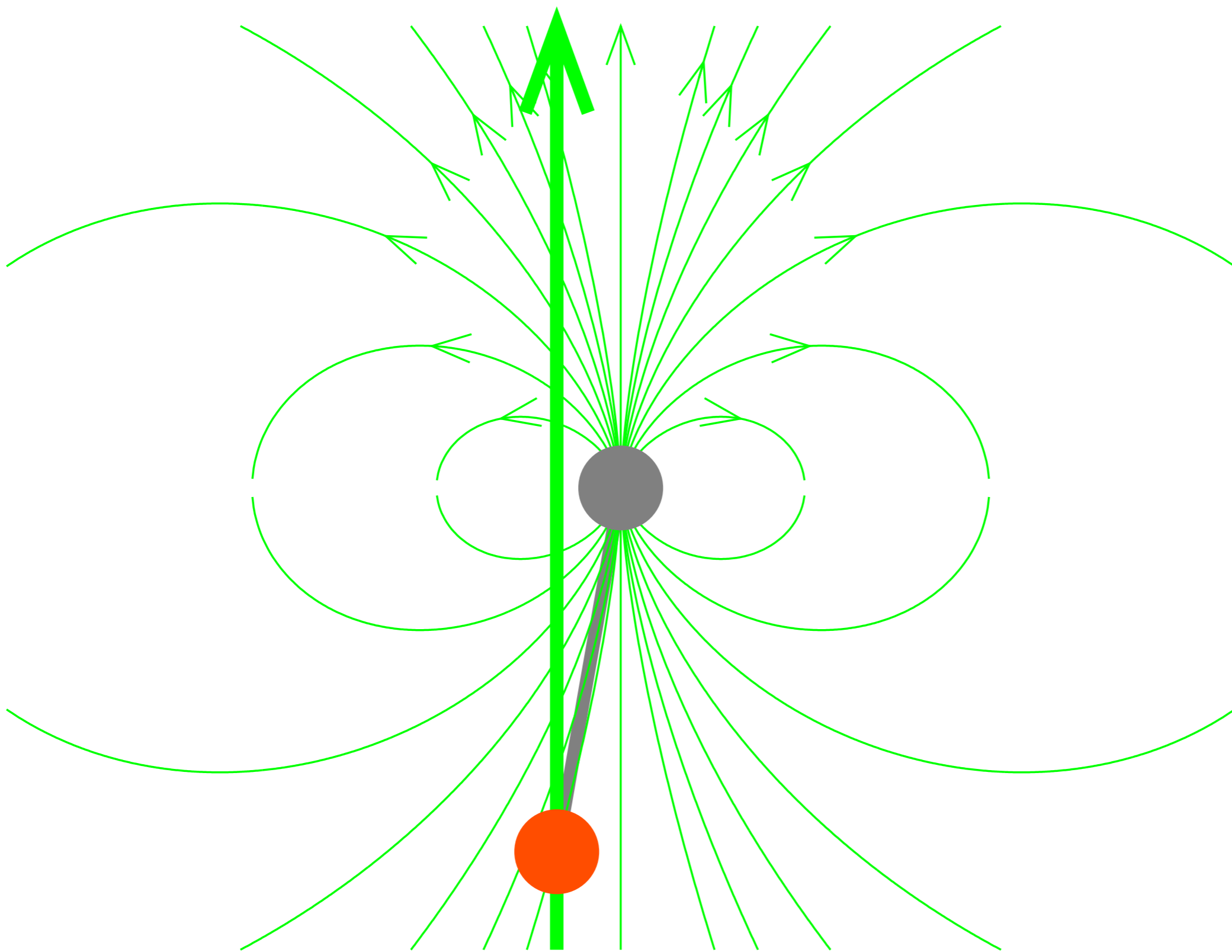
- Přímá interakce s ostatními jádry
- Interakce s elektrony
- Interakce s jádry zprostředkovaná elektrony

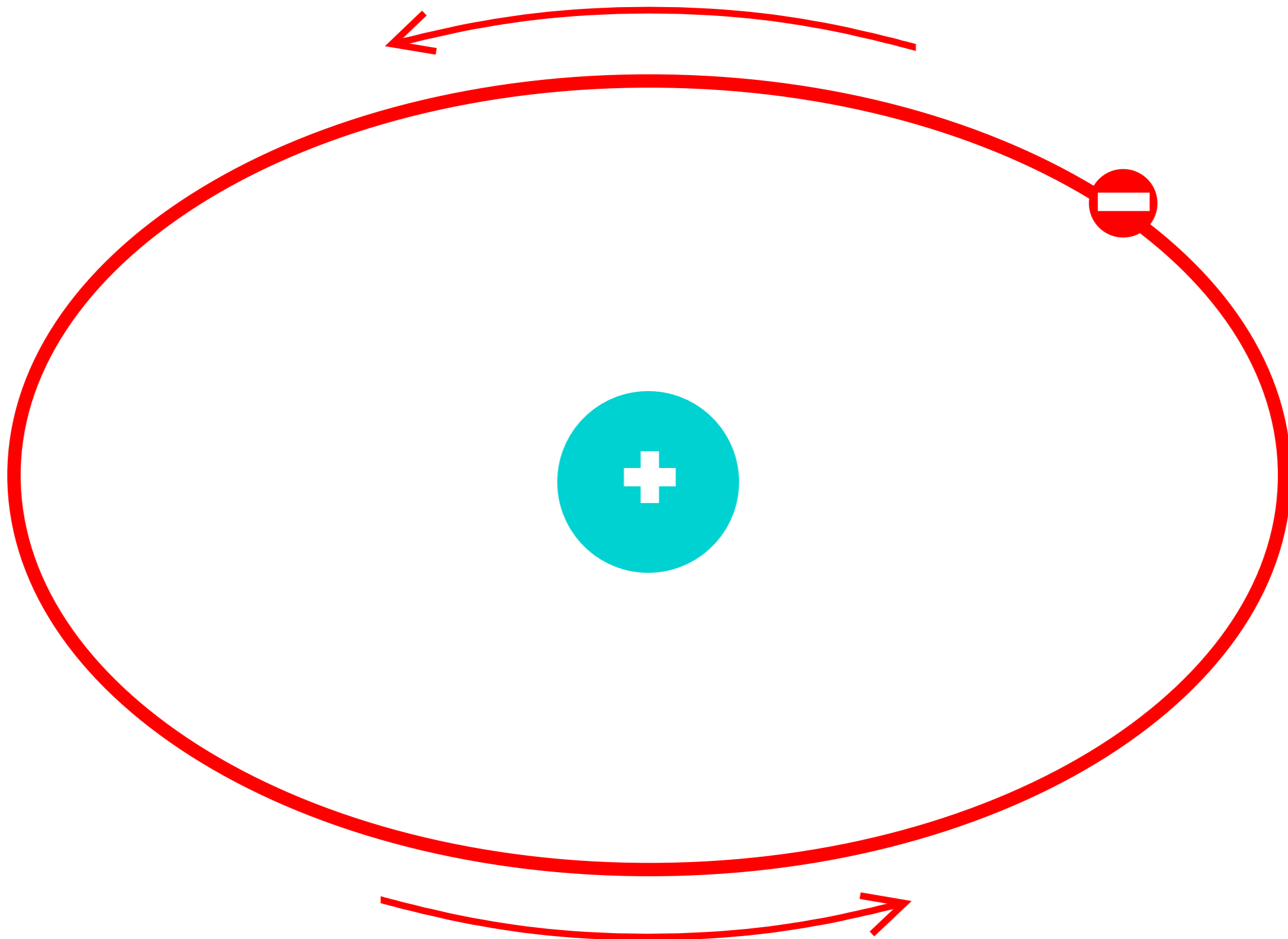


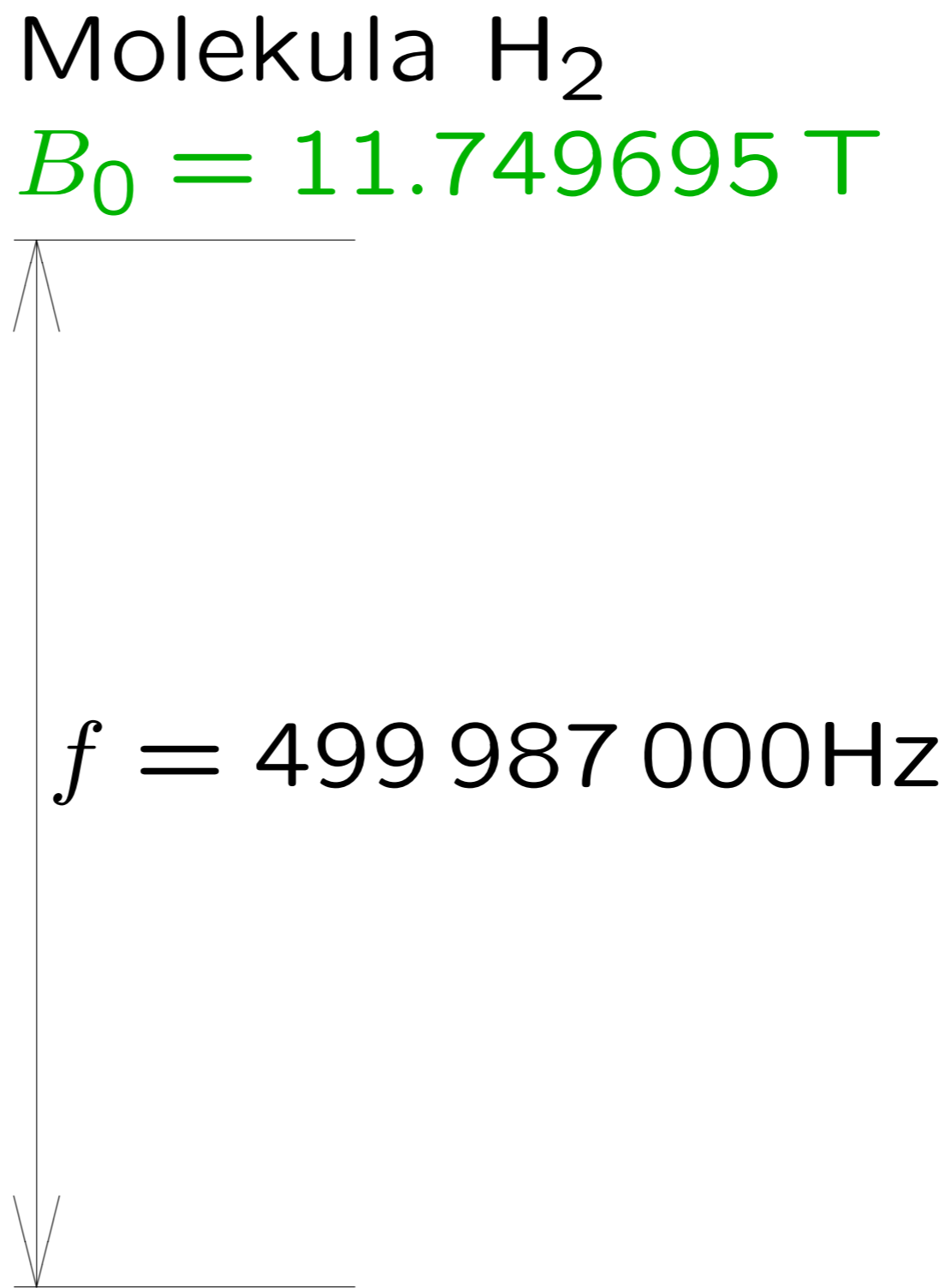
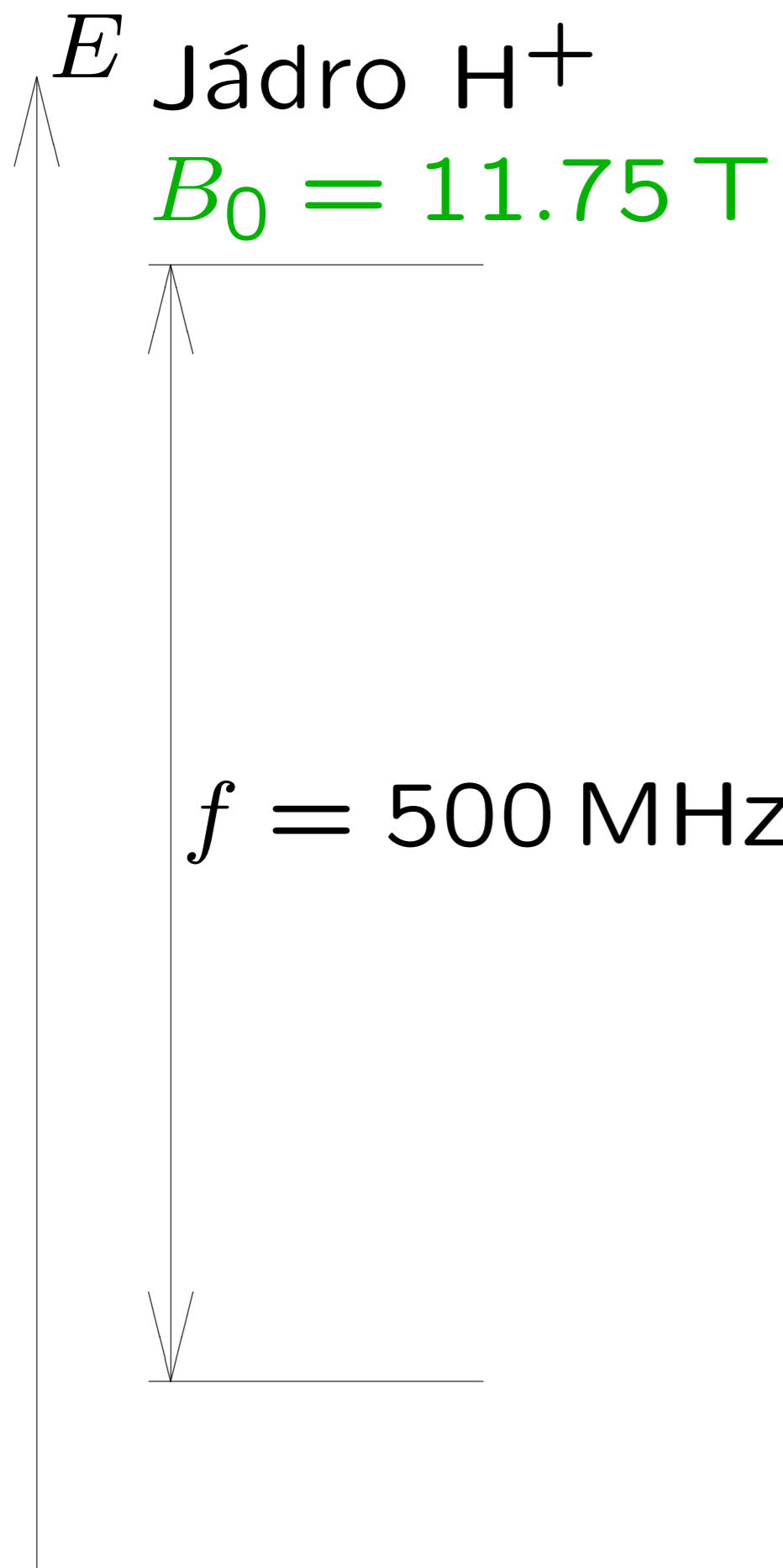


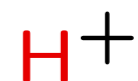
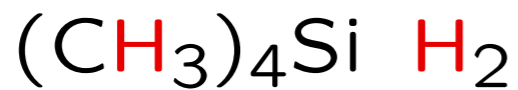
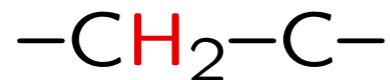
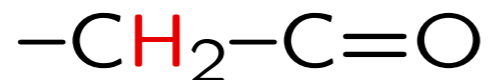
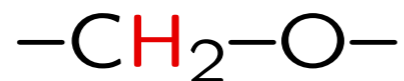
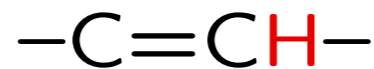
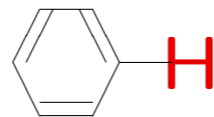
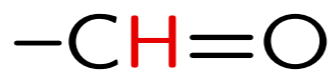










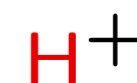
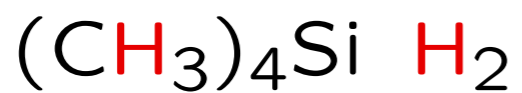
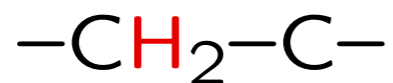
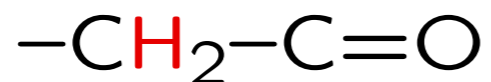
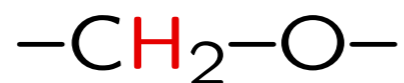
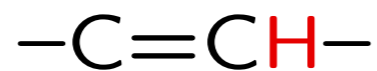
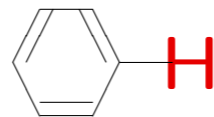
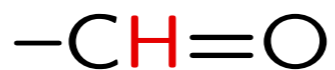


499.9985

499.9990

499.9995

500.0000 MHz

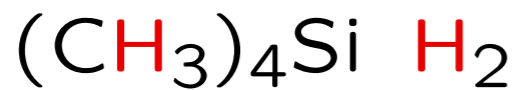
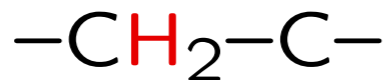
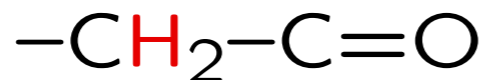
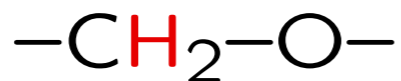
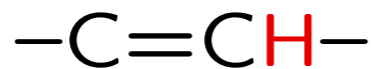
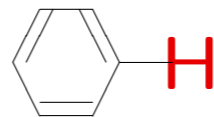
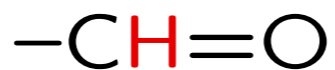


99.997 %

99.998 %

99.999 %

100.000 %

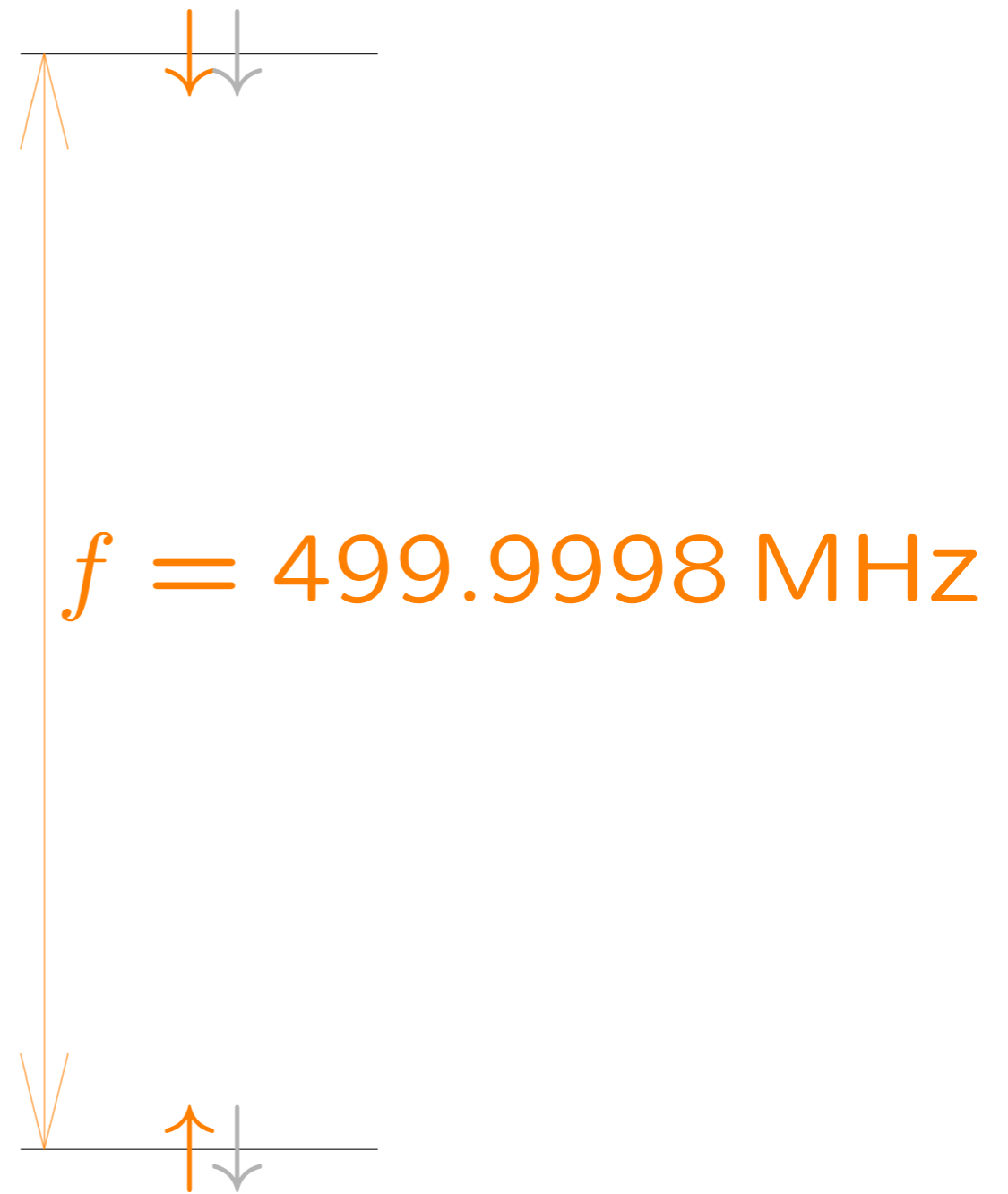
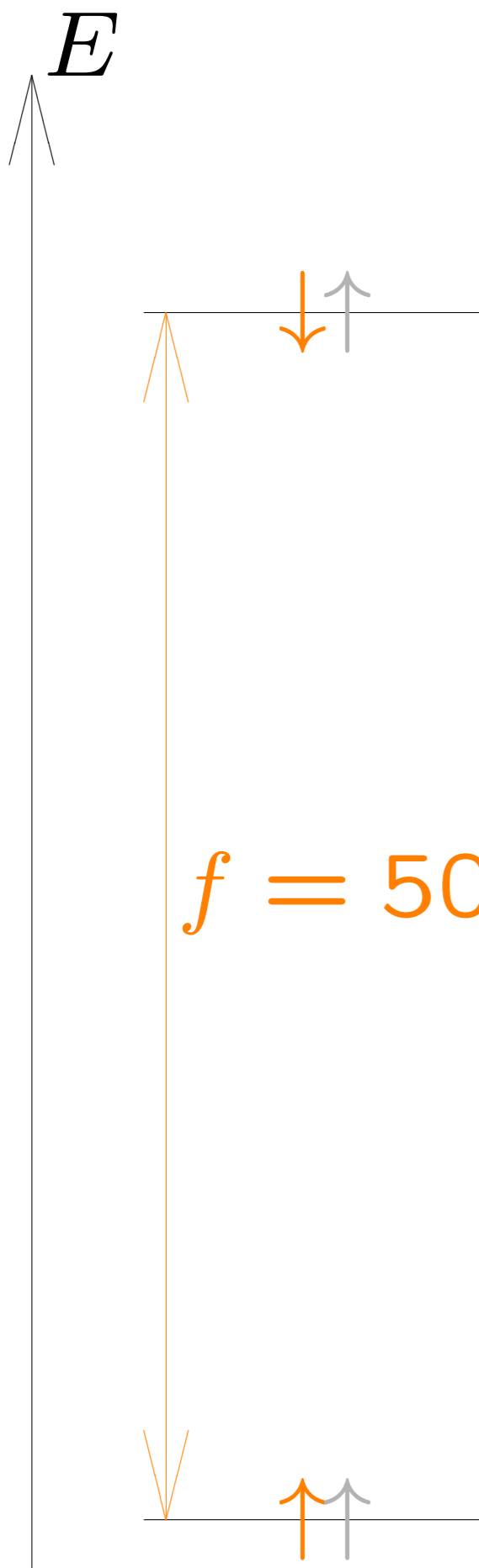


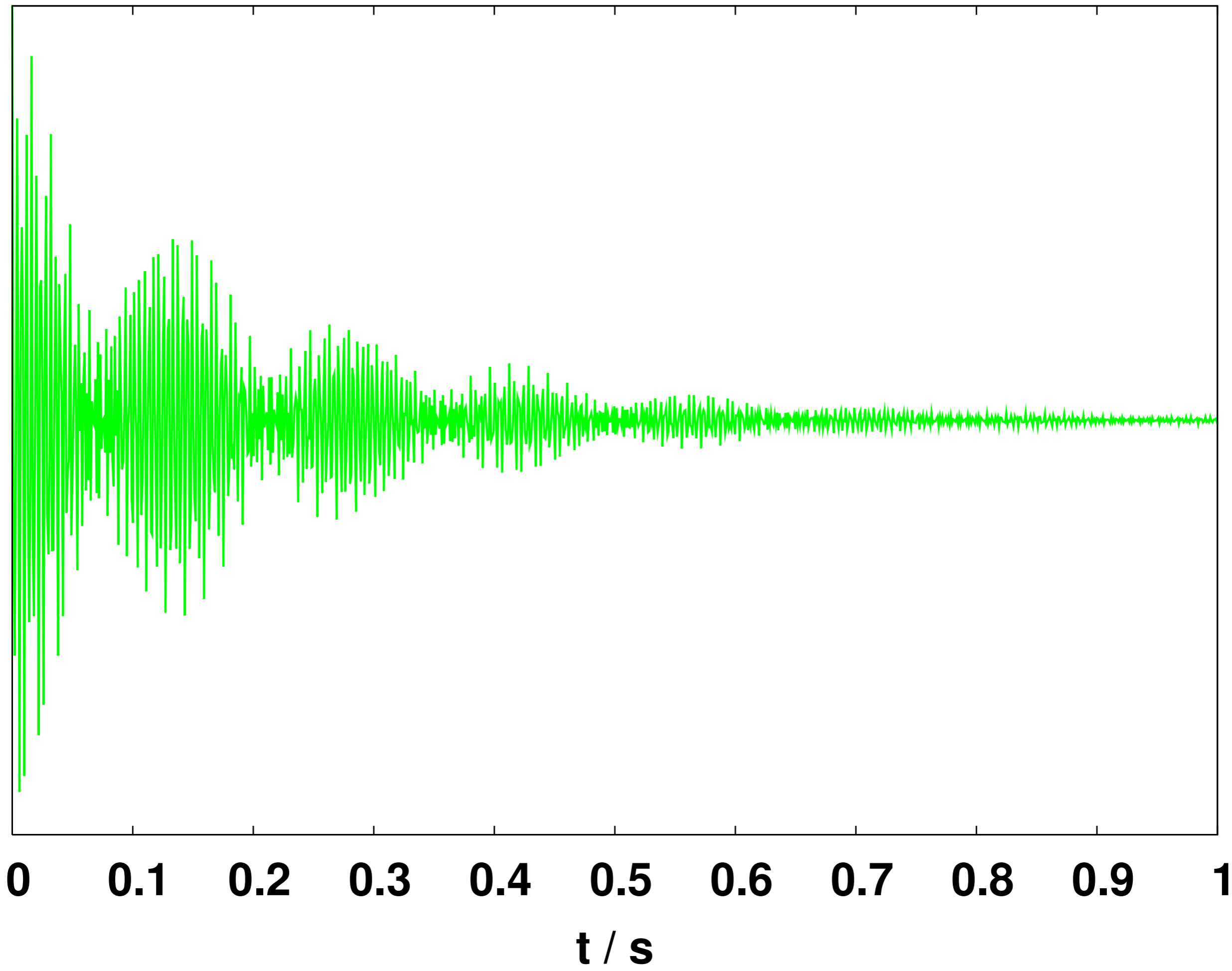
0 ppm

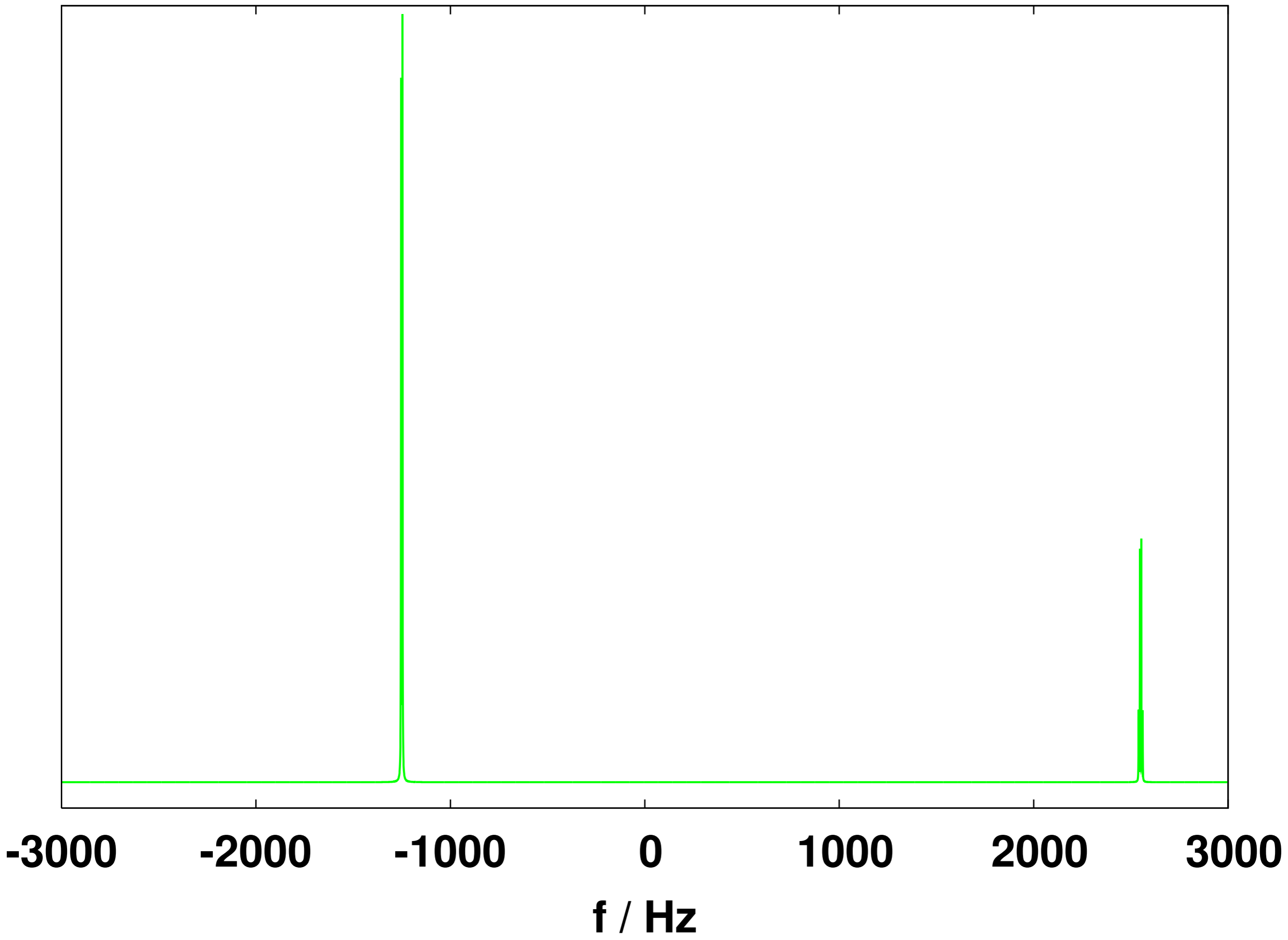
10 ppm

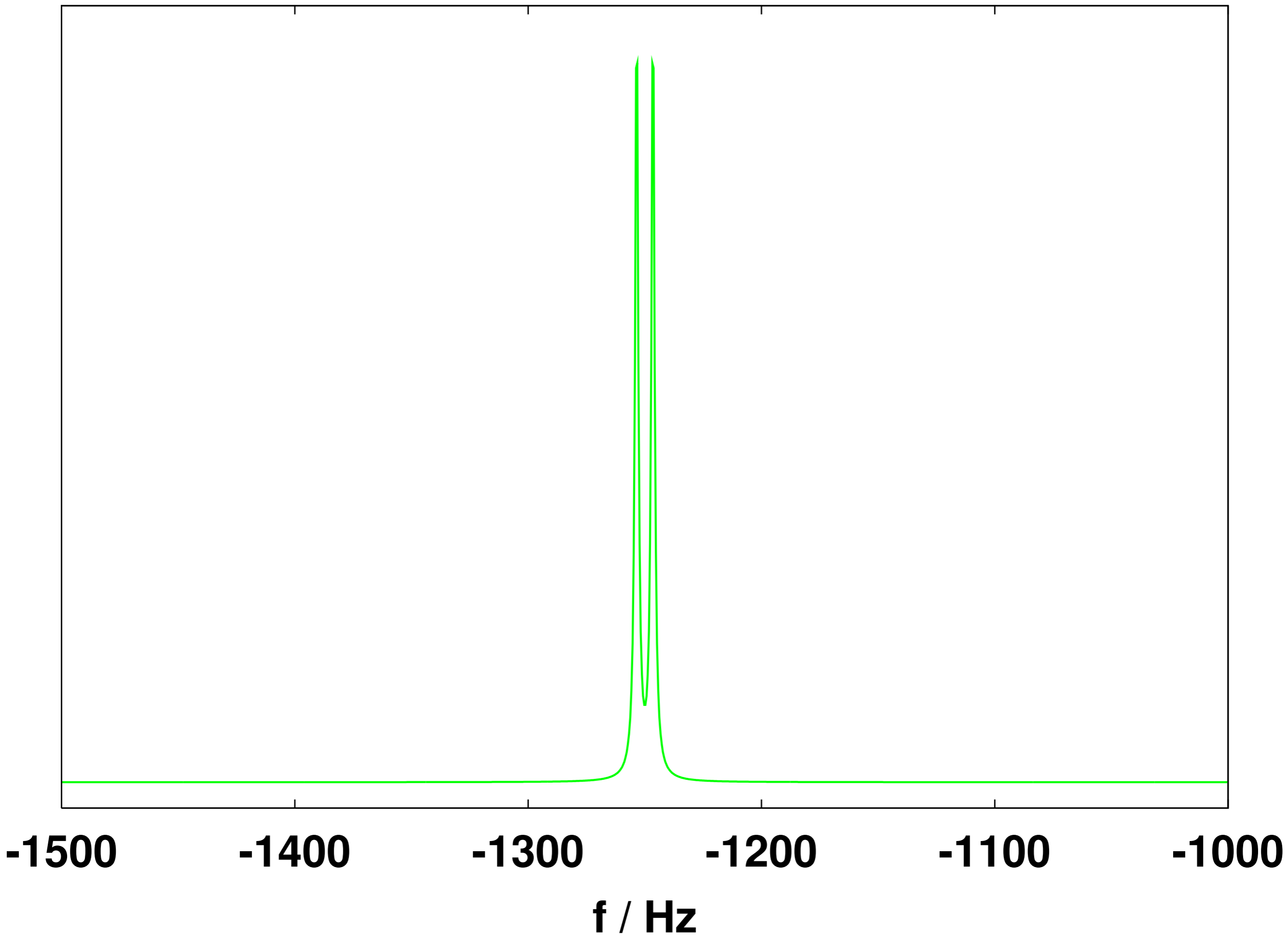
20 ppm

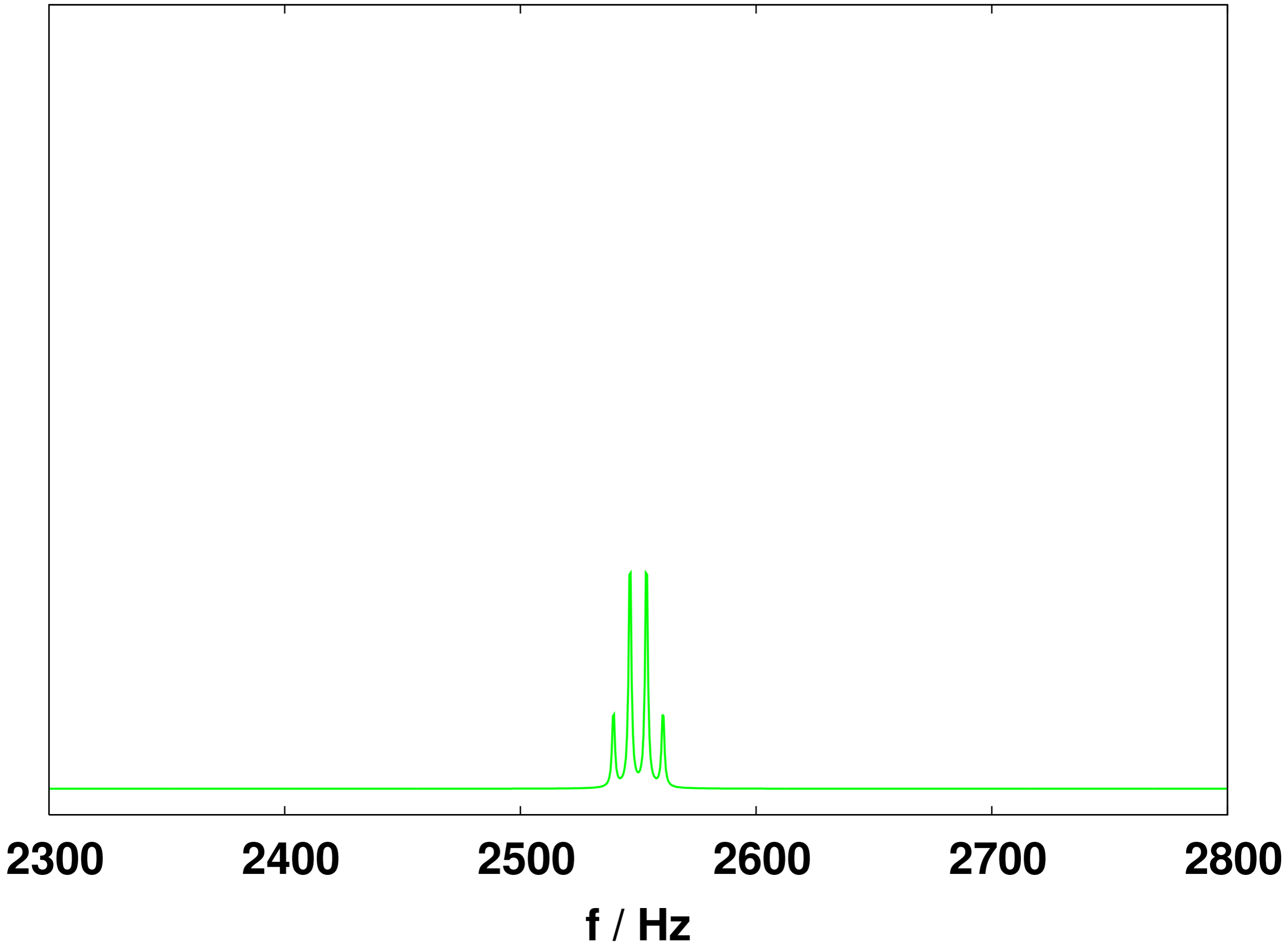
30 ppm









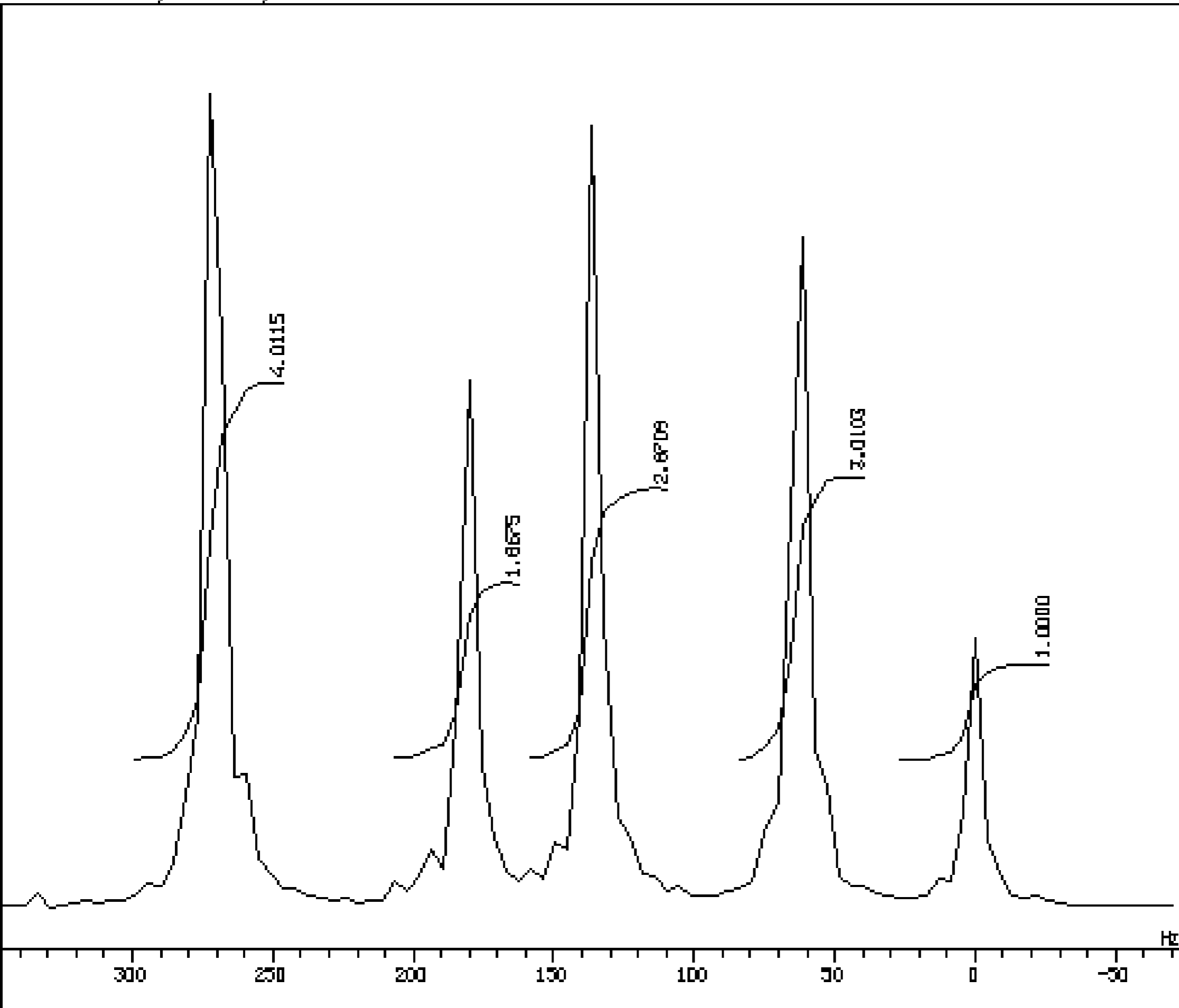


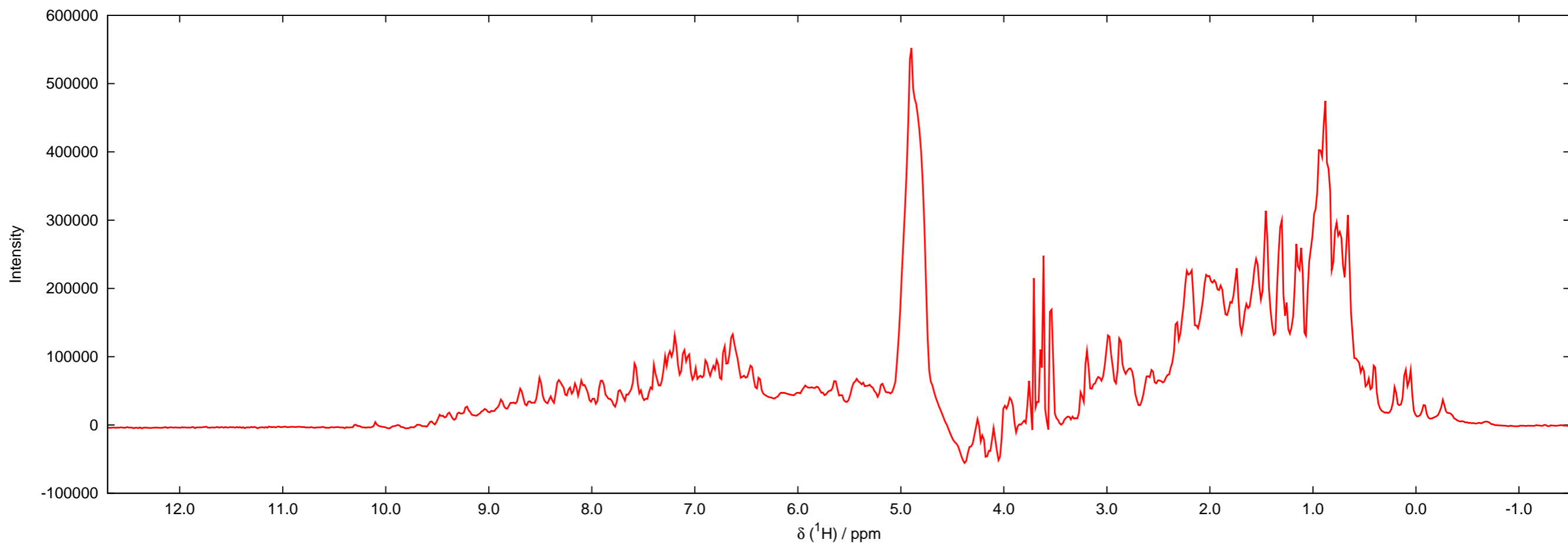
Acetaldehyd

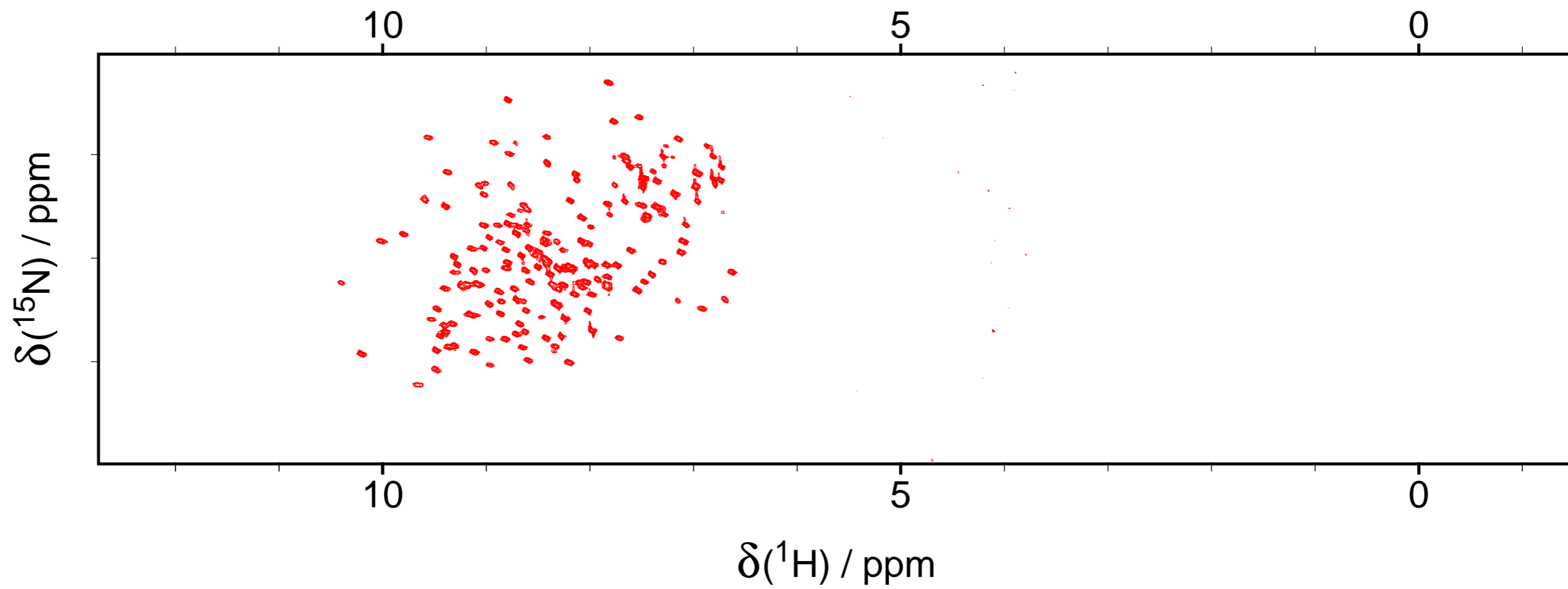
Methyl acetaldehydu

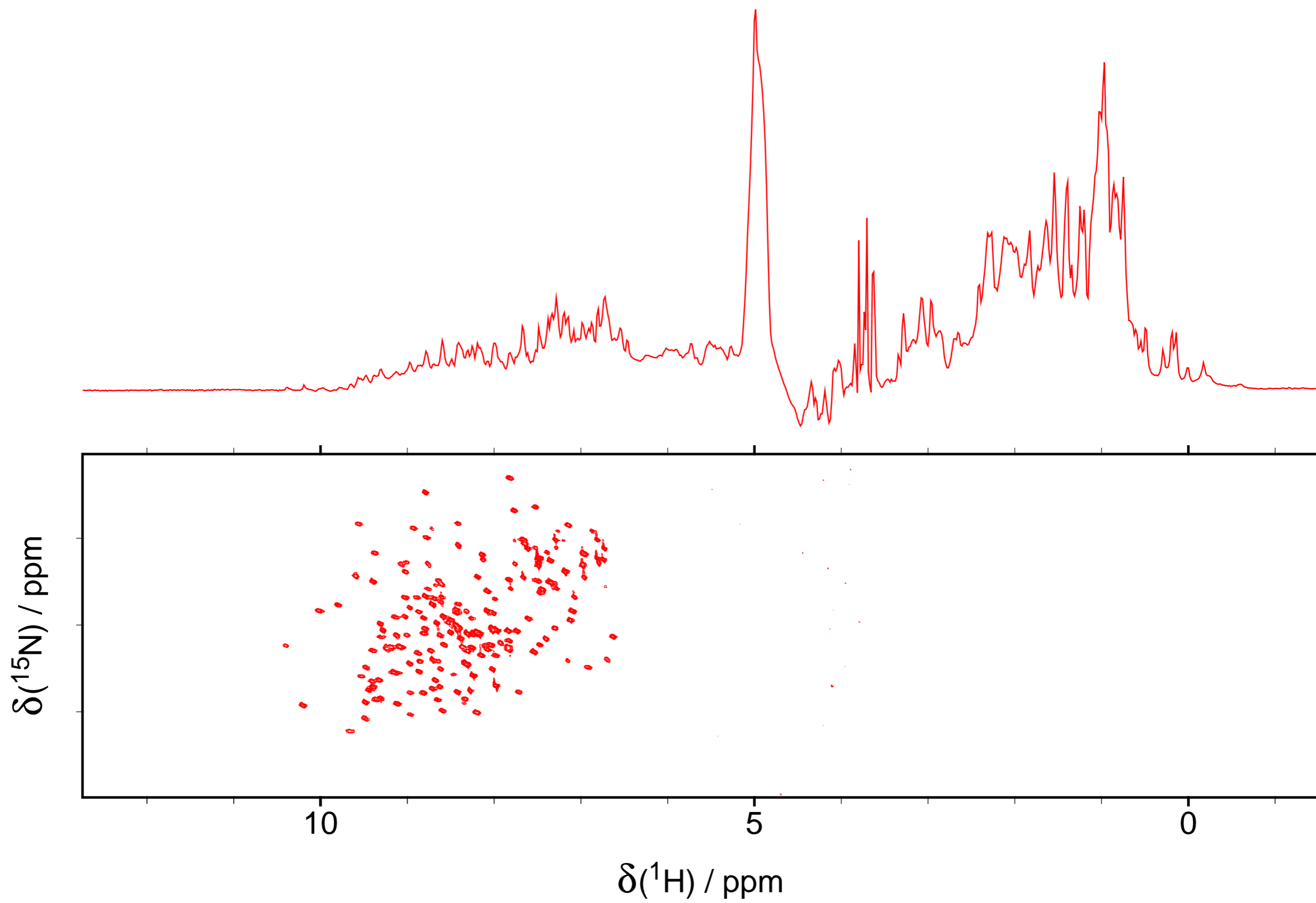
Písnička Hänschen klein

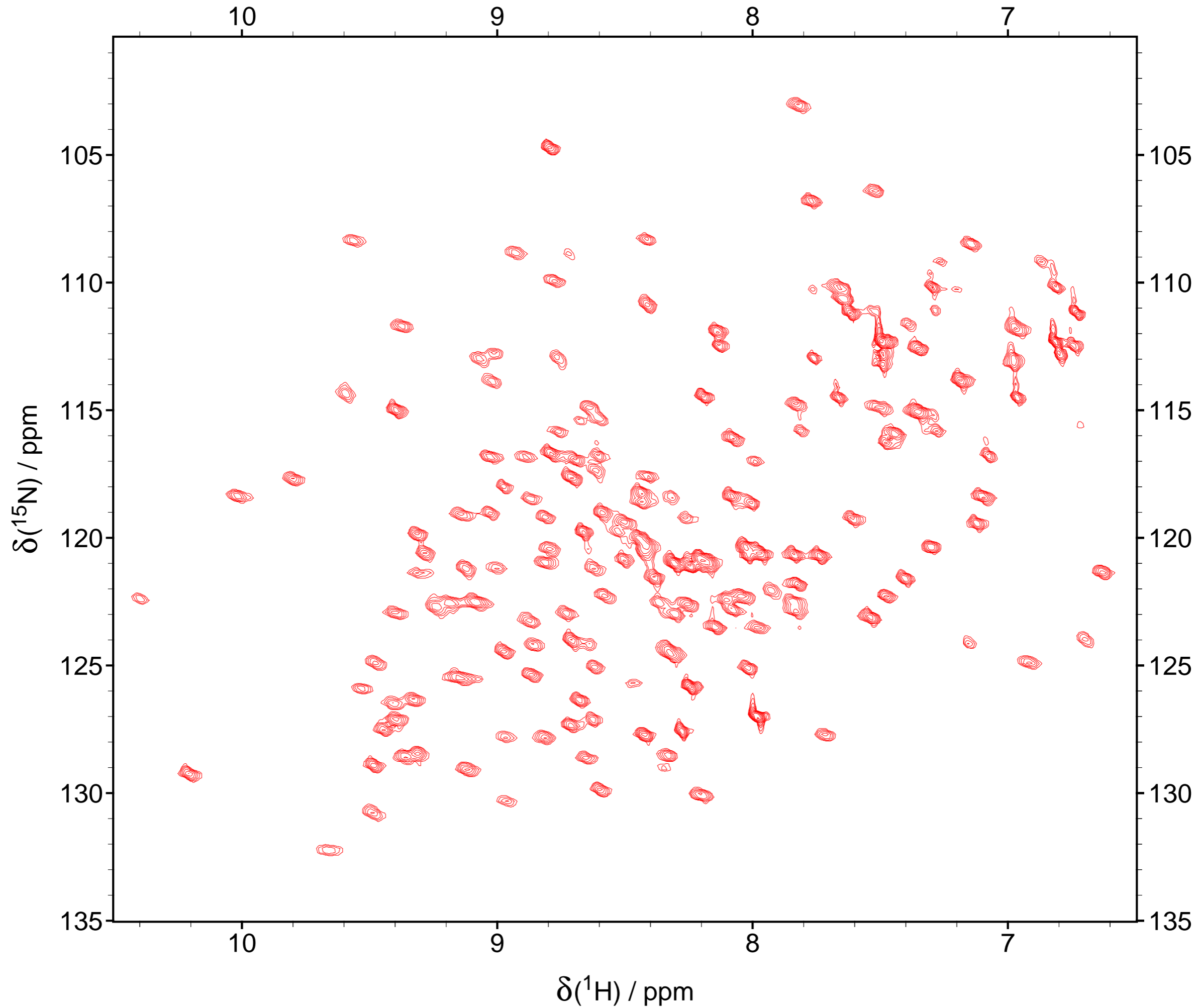
SFILE : HANS
 EXMOD : HANS
 IRMOD : NON
 POINT : 2048
 SAMPD : 2048
 FREQU : 9000.90 Hz
 FILTR : 4500 Hz
 SCANS : 1
 QUANTY : 0
 ACQTH : 0.7275 sec
 PD : 2.7231 sec
 RGAIN : 10
 PW1 : 1.00 usec
 OBNUC : 1H
 OBFRQ : 500.00 MHz
 OBSET : 160200.00 Hz
 IRNUC : 13C
 IRFRQ : 125.65 MHz
 IRSET : 127958.00 Hz
 IRATN : 511
 IRRPW : 50.0 usec
 IRBP1 : 50
 IRBP2 : 6
 IRNS : 0
 TRNUC : 1H
 TRFRQ : 500.00 MHz
 TRSET : 162410.00 Hz
 TRATN : 511
 TRRPW : 50.0 usec
 TRBP1 : 30
 TRBP2 : 6
 TRNS : 0
 CTEMP : 24.1 c
 CSPED : 11 Hz
 SLVNT : C6D6
 RESOL : 4.39 Hz
 NNUC : 8
 BF : 0.10 Hz
 GF : 0.00 Hz
 PF : 840 cp
 ABSFO : -92.11 deg
 ABSF1 : 0.00 deg
 T1 : 0.00 s
 T2 : 0.00 s
 T3 : 90.00 s
 T4 : 100.00 s
 REFVL : 0.00 ppm
 T19F : 902
 XE : 421.92 Hz
 XS : -676.83 Hz
 Y6 : 0.001

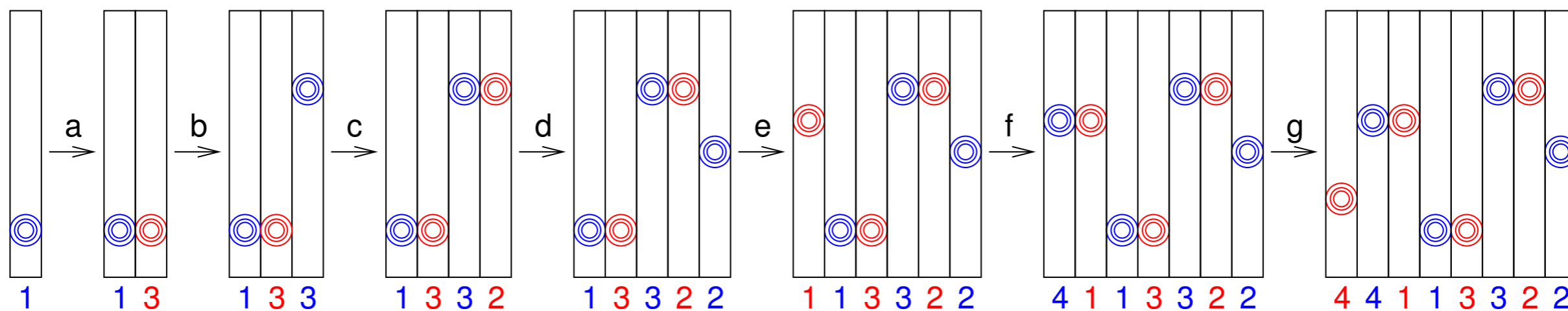
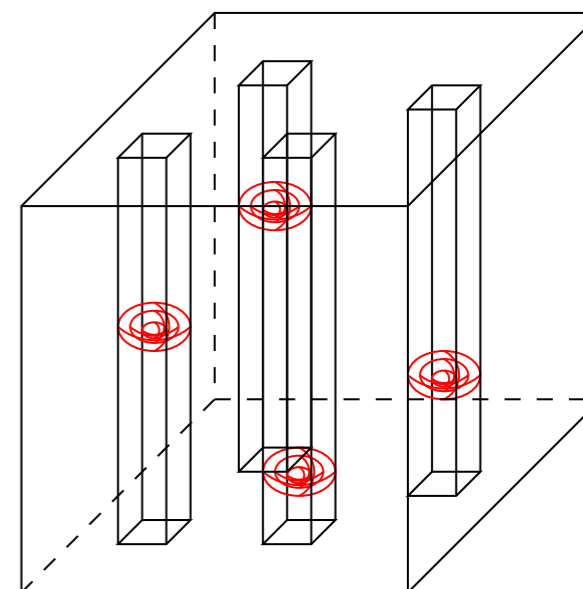
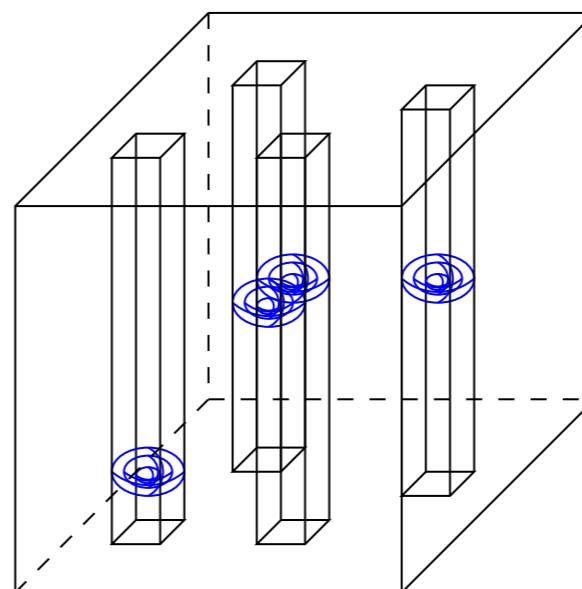
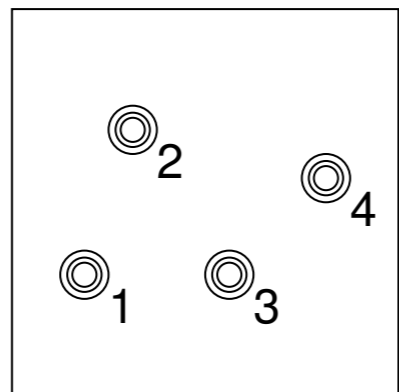
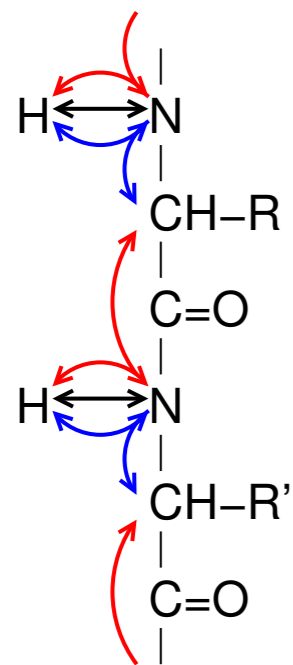


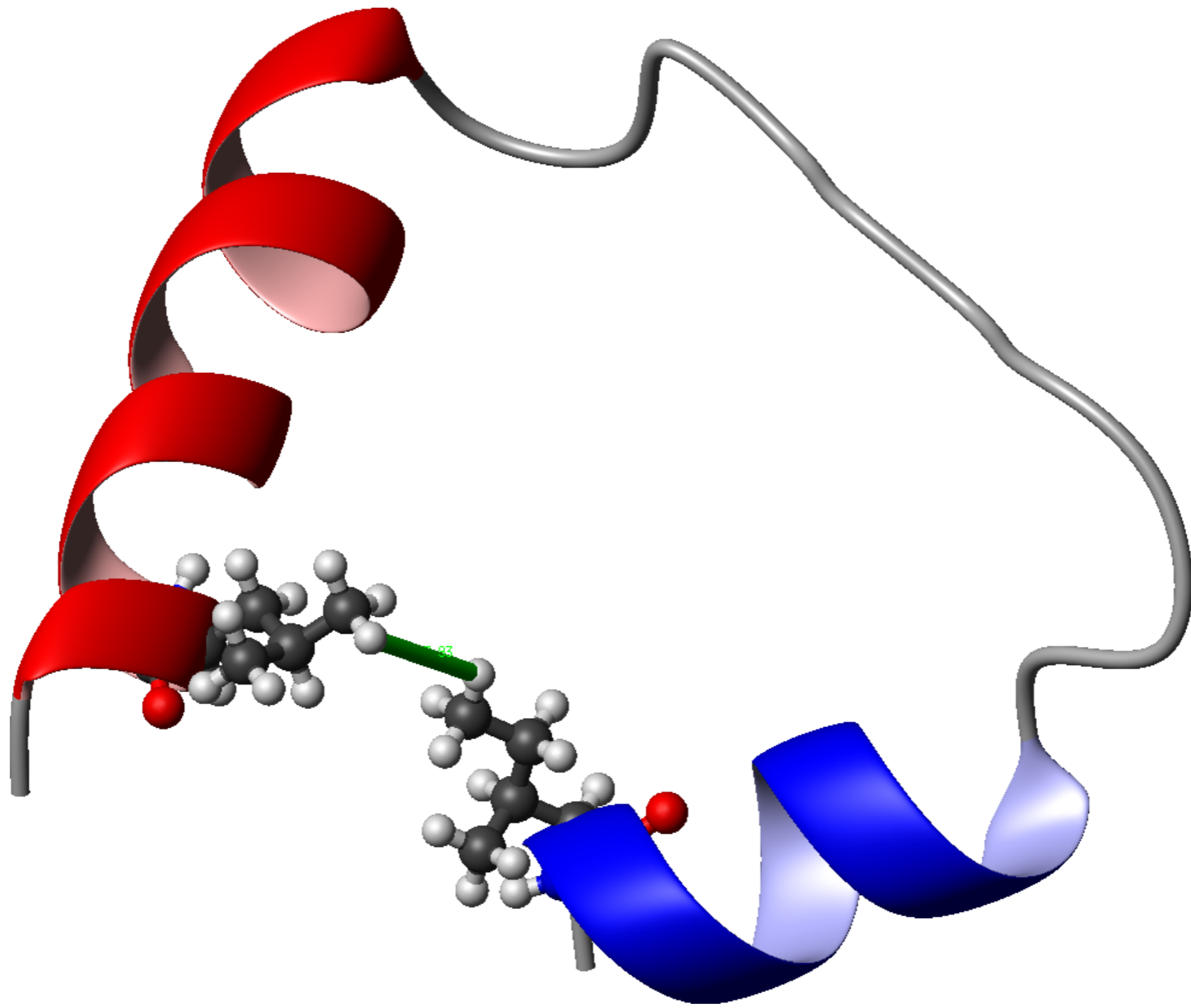


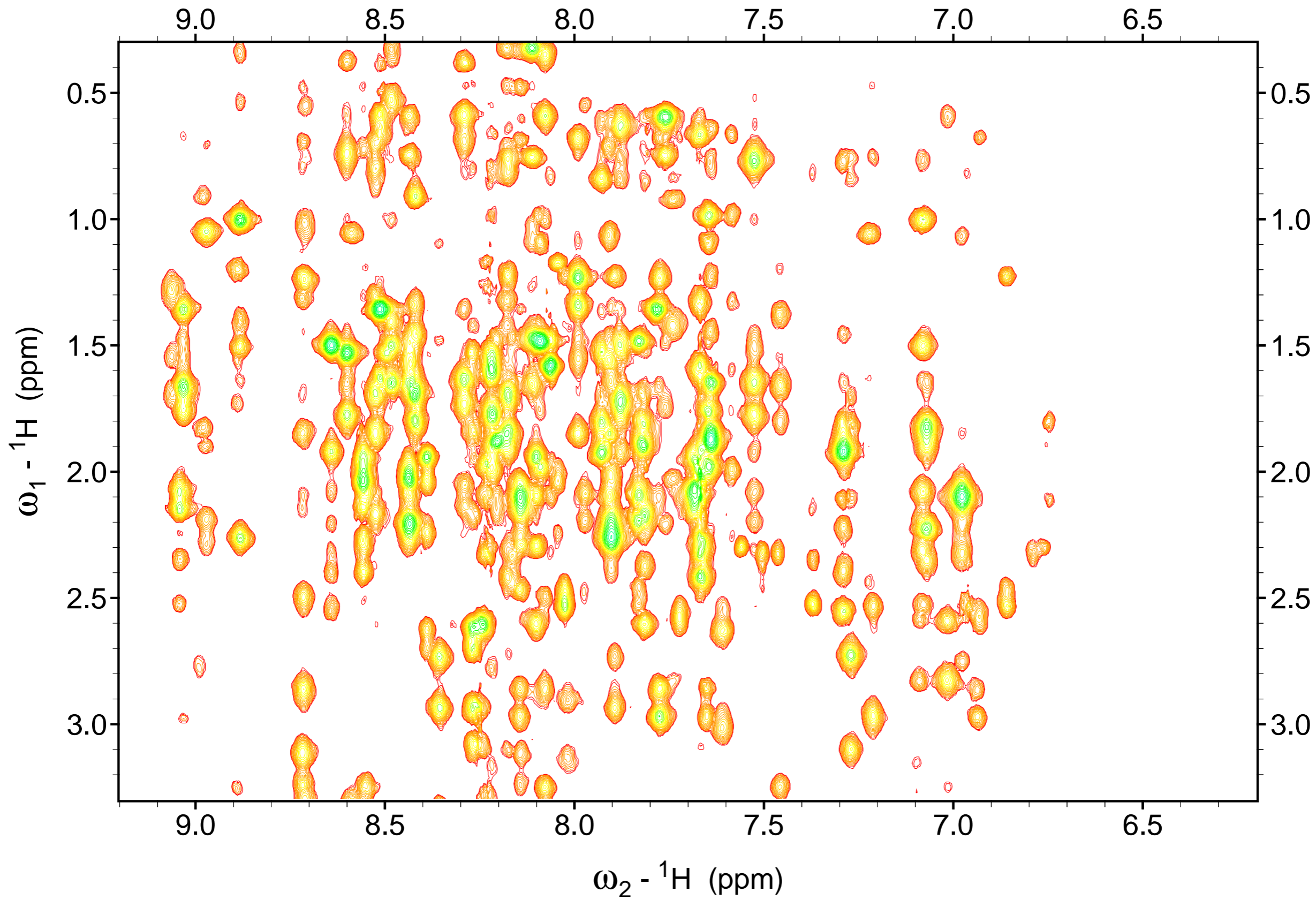


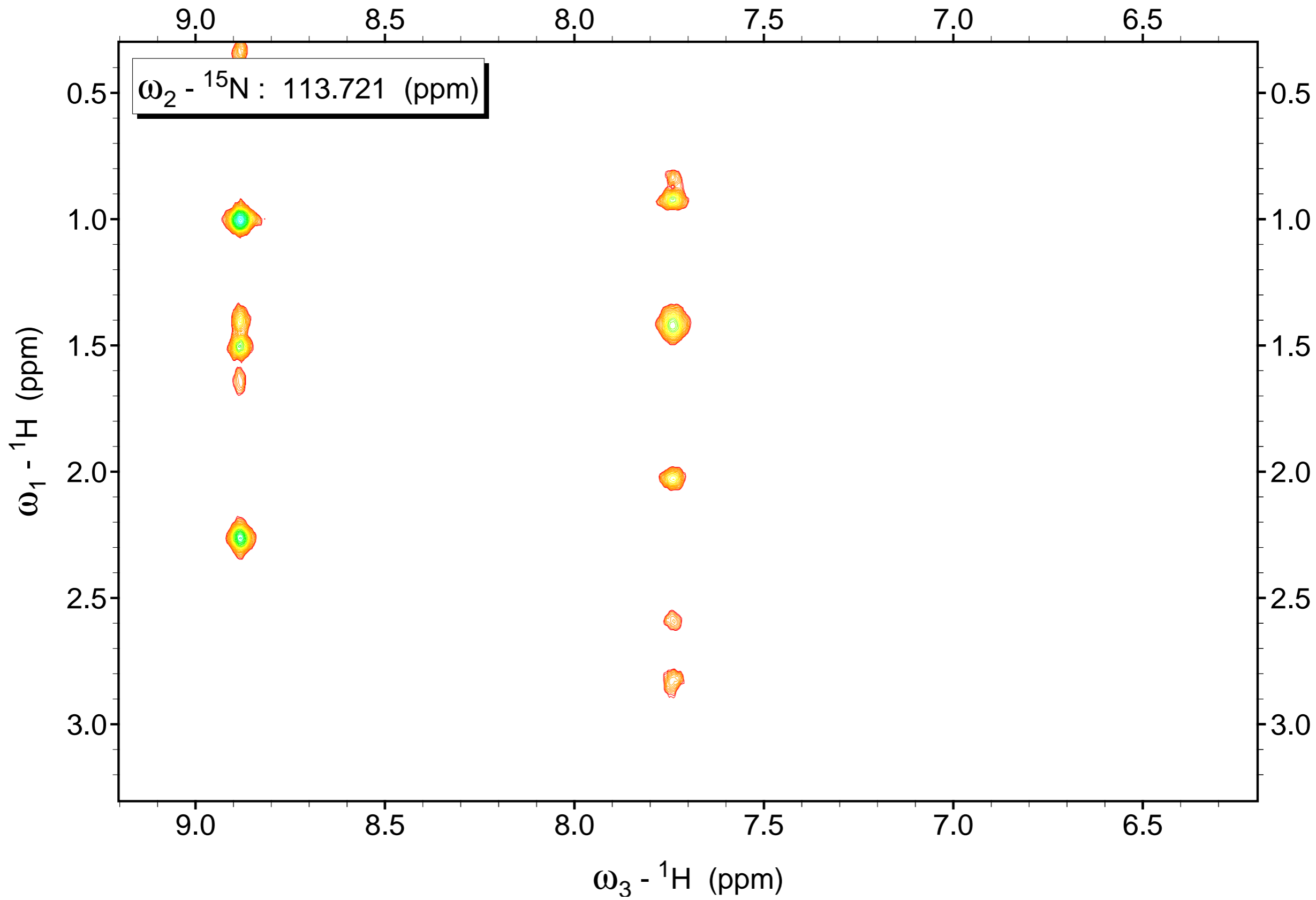


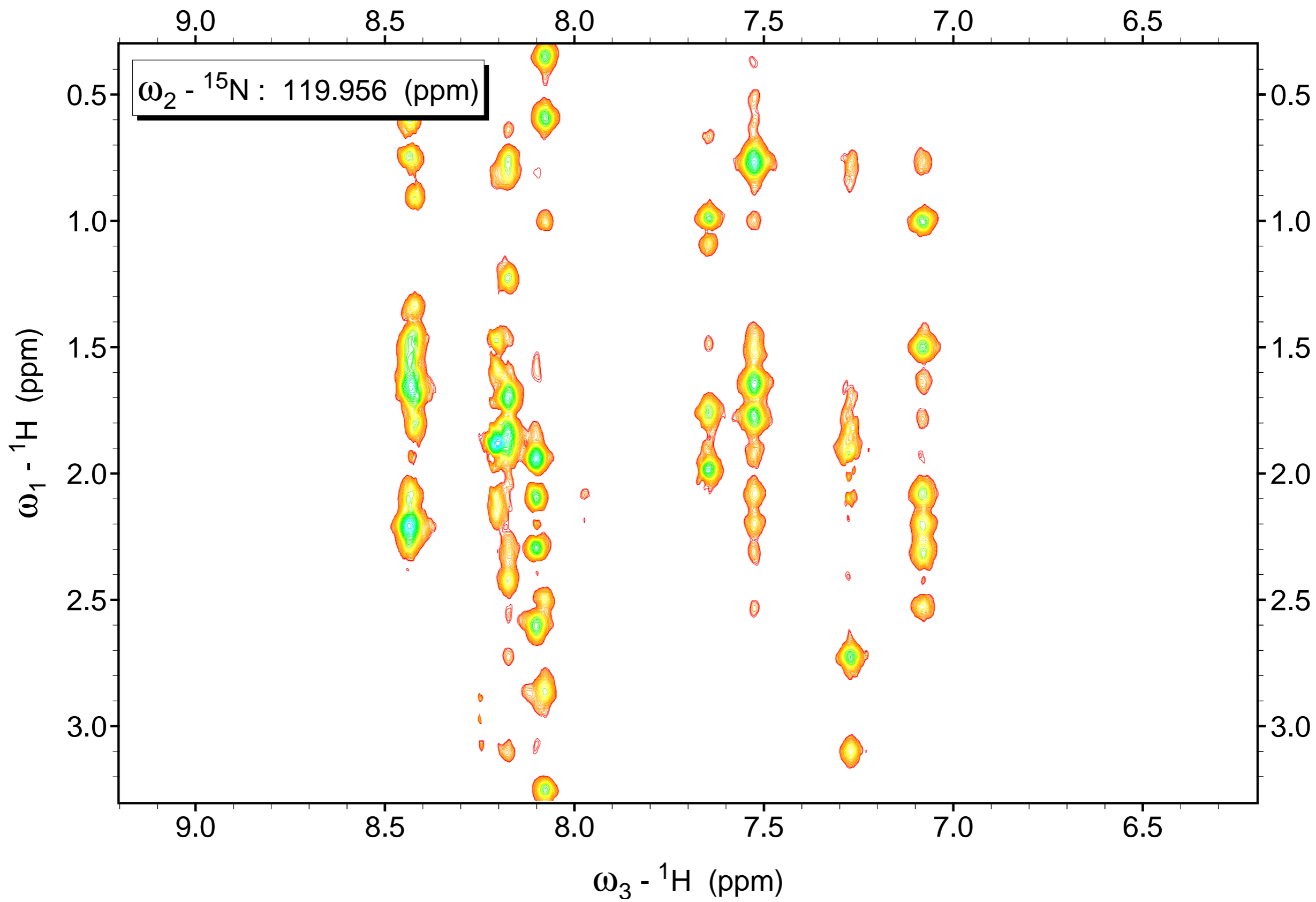


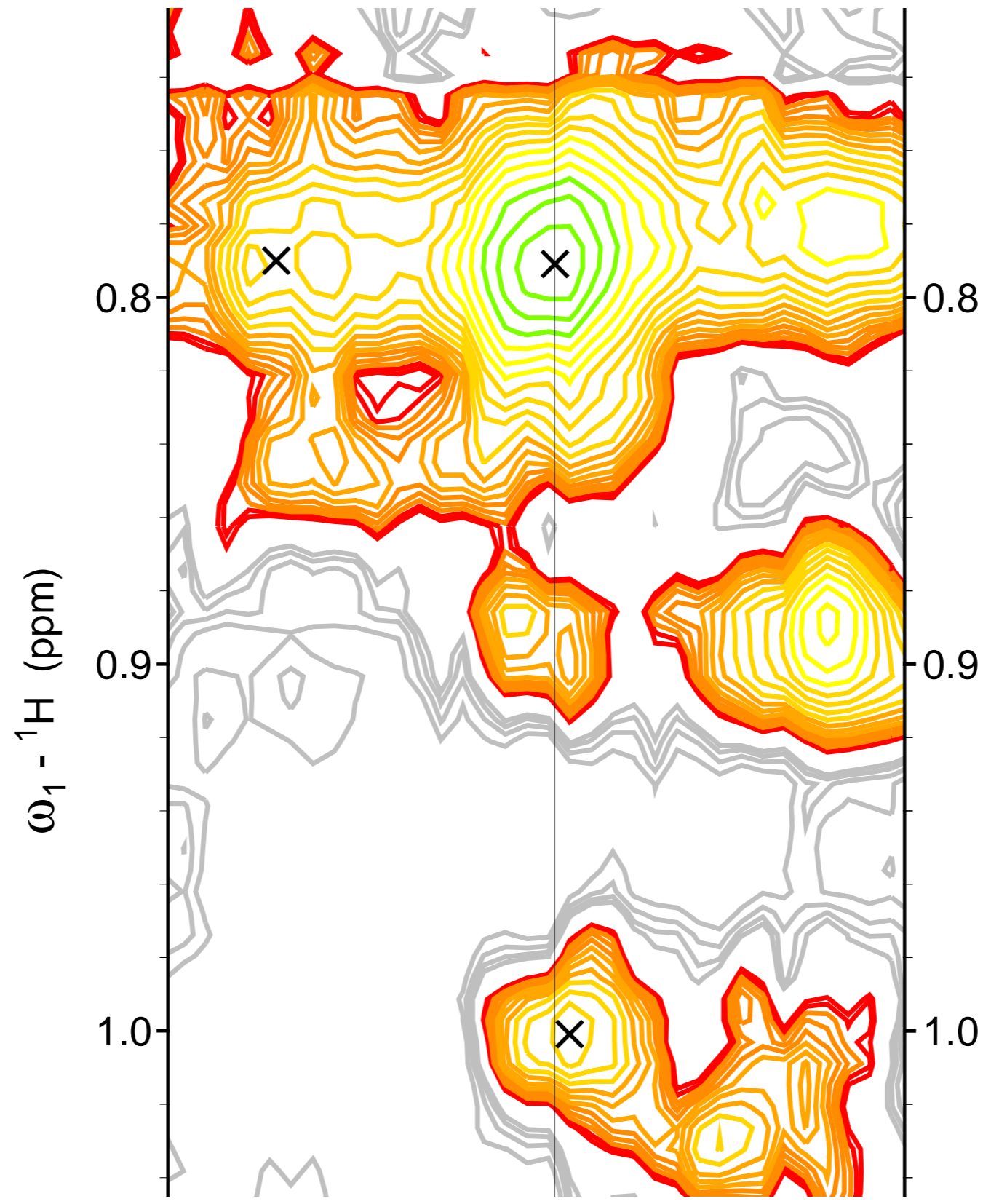


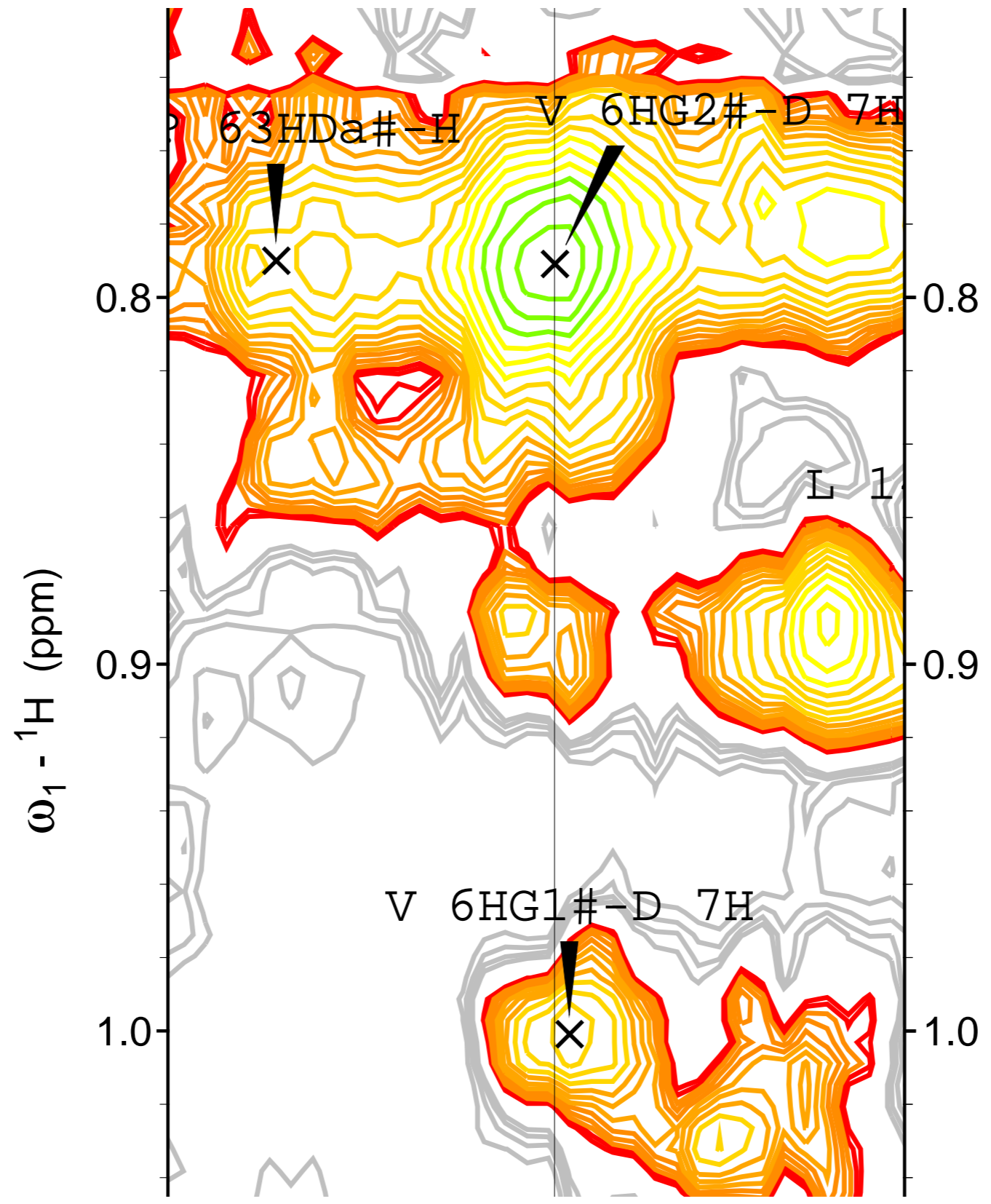












$$\frac{S}{S_{\text{ref}}} = \left(\frac{r_{\text{ref}}}{r}\right)^6 \quad (1)$$

$$r = r_{\text{ref}} \sqrt[6]{\frac{S_{\text{ref}}}{S}} \quad (2)$$

Známé vzdálenosti protonů

geminální v CH ₂ skupině	H-C-H	0.17 nm
<i>ortho</i> v aromatickém kruhu	H-C=C-H	0.25 nm
<i>meta</i> v aromatickém kruhu	H-C=CH-C-H	0.42 nm

