

## S1010 - Laser Spectroscopy on Neutron-Deficient Francium S1341 - Laser Spectroscopy on Neutron-Rich Rubidium

Thomas Procter

TRIUMF Forum 14 - August - 2013



• Quick overview of polarizer setup

Introduction of the physics motivations for the two experiments

• Scheduled back to back 18<sup>th</sup> - 28<sup>th</sup> August

• First look at data obtained



## Myself

• Originally from town called Bingley in Northern England





 Undergraduate and PhD at University of Manchester work based at ISOLDE, CERN

• Started working at TRIUMF July 2013



#### Polarizer



Taken from O. Shelbaya presentation 2012

Polarizer



#### Nuclear Observables



- Coupling of nuclear spin with total electron angular momentum produces hyperfine structure
- Measurement of nuclear **spin**, **magnetic** and **electric** moments



- Isotope shift arises from change in energy of atomic transition between two isotopes
- Caused by change in mass and size of nucleus/shape. Can be used to extract changes in **mean-square charge radii**



## Francium Motivation

Magnetic hyperfine interaction arises from magnetic field of electrons interacting with magnetisation of the nucleus.



Figure 1: Probability distributions of relevant atomic and single particle nuclear states in Fr.

- Different atomic states have differing radial overlaps. Change in hyperfine A values
- Francium is heaviest alkali element therefore large overlap of nucleus
- N-def Fr lie around N = 126 n-shell closure; almost single particle nature







				0,
E(level) (MeV)	Jn	Δ(MeV)	T <sub>1/2</sub>	Decay Modes
0.0	(3+)	0.6073	1.8 s <i>3</i>	α:92.00 % ε:8.00 %
0.0410	(7+)	0.6483	1.6 s +5-3	α:90.00 % ε:10.00 %
0.3160	(10-)	0.9233	0.8 s 2	a : 74.00 % ε : 26.00 %

Ground and isomeric state information for <sup>204</sup><sub>87</sub>Fr



Q<sub>EC</sub>(8600) Q<sub>α</sub>7170



www.nndc.bnl.gov











206
87

E(level) (MeV)	Jn	Δ(MeV)	T <sub>1/2</sub>	Decay Modes
0.0	(2+,3+)	-1.2424	≈ 16 s	a ≈ 84.00 % ε ≈ 16.00 %
0.0	(7+)	-1.2424	≈ 16 s	a ≈ 84.00 % ε ≈ 16.00 %
0.5310	(10-)	-0.7114	0.7 s 1	IT : 95.00 % a : 5.00 %

www.nndc.bnl.gov





## **Rubidium Motivation**

- Shape coexistence of different nuclear shapes at similar excitation energies
- Observed in regions with sharp changes in trends of RMS charge radii
- Extend charge radii measurements in Rb and investigate deformation











- Slight difference in isotope shifts from literature
- Two states in <sup>98</sup>Rb: Low spin (Possibly 0) and higher spin with hyperfine splitting
- Many scans taken on each isotope to infer spin

![](_page_13_Picture_0.jpeg)

![](_page_13_Figure_2.jpeg)

![](_page_14_Picture_0.jpeg)

![](_page_14_Figure_2.jpeg)

Isomeric <sup>98</sup>Rb

![](_page_15_Picture_0.jpeg)

- HFS of <sup>204,205,206</sup>Fr: 2 isomers in both <sup>204</sup>Fr and <sup>206</sup>Fr
- HFS of <sup>98,98m,99</sup>Rb measured and lifetime measurements of <sup>98,98m</sup>Rb
- Analysis on hyperfine coefficients of isotopes, nuclear spins and investigation into shape changes across isotopes and isomers

![](_page_16_Picture_0.jpeg)

## Thanks for Listening

On behalf of the S1010 and S1341 collaborators:

![](_page_16_Picture_3.jpeg)

# Large thank you to Francium Trap group for use of their laser system