the First Laser System for BECOLA Project at NSCL

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What is BECOLA?

BECOLA stands for BEam COoling and LAser spectroscopy.

A collinear laser spectroscopy experiment for laser based nuclear physics.
Laser: Atomic $\leftrightarrow$ Nuclear Physics

ex. $^{23}\text{Na}$

$L_e \quad J = L_e + I_e \quad F = J + I_N$

$3p$ $\rightarrow$ $3s$

$\sim 508$ THz (orange)

$2S_{1/2} \rightarrow 2P_{1/2}$

$0.5$ THz

$3P_{3/2}$ $\rightarrow$ $3S_{1/2}$

$0.0018$ THz

$0.00018$ THz

$0.00011$ THz

Fine Structure $\leftrightarrow$ Hyperfine Structure
Hyperfine Interaction

\[ H \sim A \cos(\hat{I}J) + B \frac{3 \cos^2(\hat{I}J) - 1}{2} \]

- \( A \sim \mu_I H \)
- \( B \sim eqQ_I \)

• determine \( f \rightarrow A, B \rightarrow \) nuclear structure
BECOLA beam line

Switch yard

RFQ trap Ion cooler

beam from gas stopping (60 keV)

Collinear Laser Spectroscopy

charge exchange cell

photon detection

Laser

β NMR
Where is BECOLA?

Here!
Where is BECOLA?

BECOLA

Penning trap

Laser room

gas stopping (60 keV)
Laser System (conceptual)

- variable frequency -- Ti:S: 700-1000 nm, doubler: 350-500 nm
- narrow line width -- a few MHz
- short/long term stability -- stabilization system installed
Laser System (real)

doubler

Ti:S

doubler

EO modulator

ref cavity (short term FB)

He-Ne

wavelength meter (long term FB)
Tunable Ti:S Ring Laser

Matisse-TS (S/N 09-21-22) w 10 W pump
Ti:S Long Term Stability

365 THz

@ 823 nm

7 h

on

off

3 MHz

Δf/f ~ 10⁻⁸

4 °C
Frequency Doubler

doubler resonance cavity
LBO crystal
Frequency Doubling

LBO crystal @ 778 nm
$P_{\text{Ti:S}} \sim 1.3 \text{ W}$

LBO: LiB$_3$O$_5$
EO Modulator
Laser Light Diagnosis/Manipulation

~ 20 MHz

@ 411.5 nm

w EOM @ 28 MHz
Summary & immediate Projects

• BECOLA project for laser based nuclear physics is on going
• laser system installed
• beam from offline ion source in ~ mid 2010

• fiber transport of laser light to experimental area
• optimization of short/long term stability
• doubling crystals test
Collaborators

NSCL/MSU:

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