

Mössbauer Spectroscopy

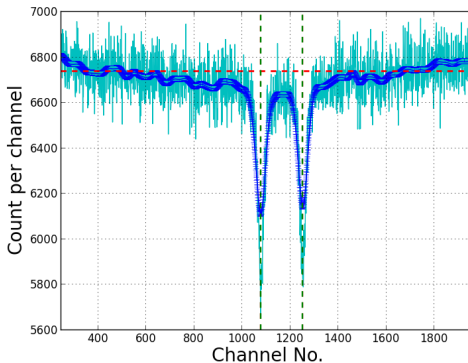
Yichao Yu

MIT

March 6, 2013

Mössbauer effect and Mössbauer spectroscopy.

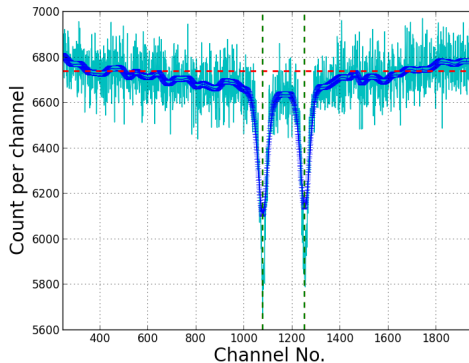
- Nuclear γ spectrum.
- Simple setup.
- Super high resolution. (10^{12})



Mössbauer spectrum of FeC_2O_4 .

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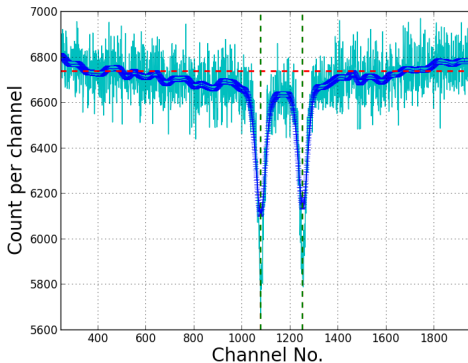
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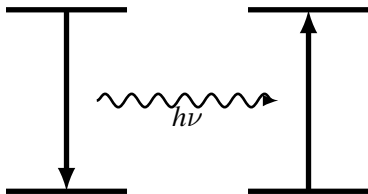
- 1 **Mössbauer effect.**
- 2 **Apparatus and samples.**
- 3 **Data and result.**
- 4 **Conclusion.**

Nuclear spectrum and recoil.

- Radio active element radiate γ -ray at characteristic frequencies.
- Radiation \rightarrow Absorption.
- Recoil momentum and doppler shift.

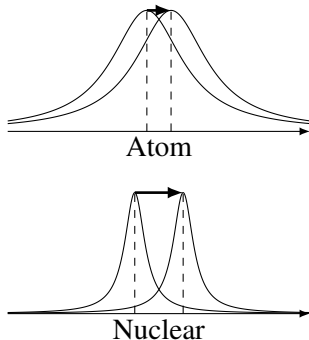
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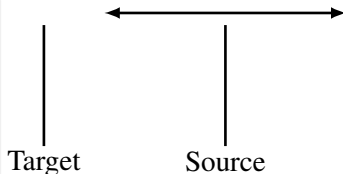
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- Momentum transfer with the whole crystal. \rightarrow Recoilless.
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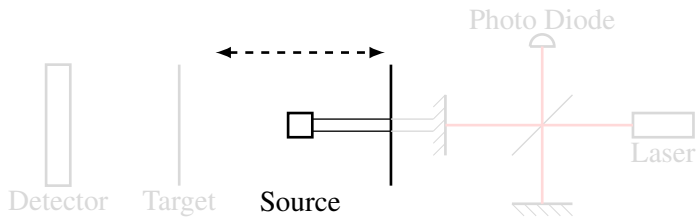
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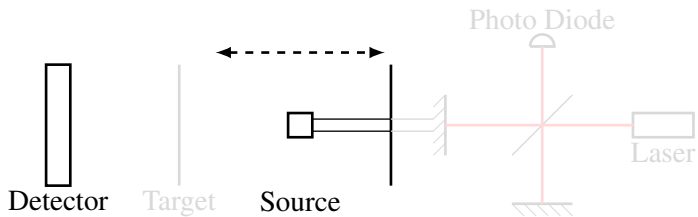
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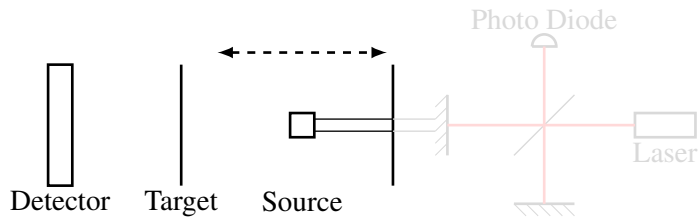
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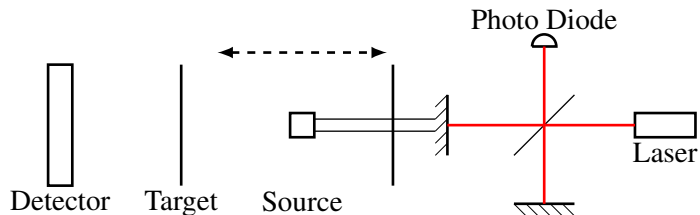
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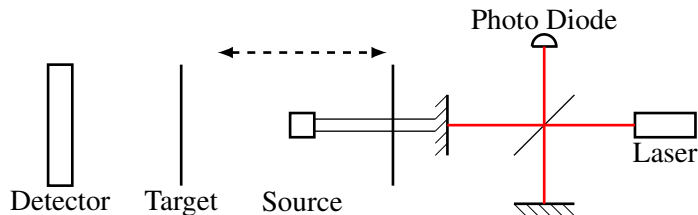
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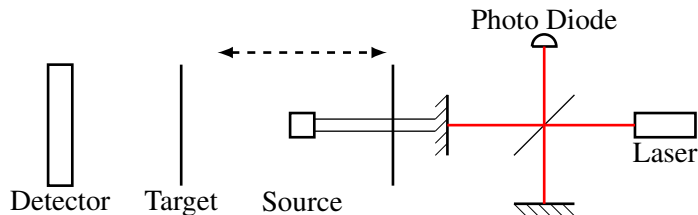


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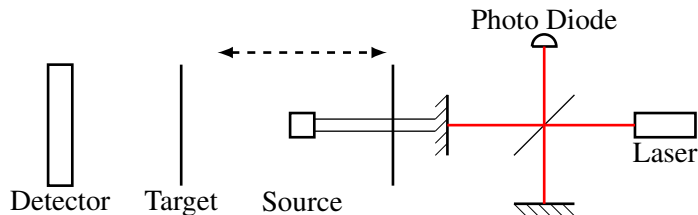
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- First decay into excited state of ^{57}Fe .
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Effects and samples.

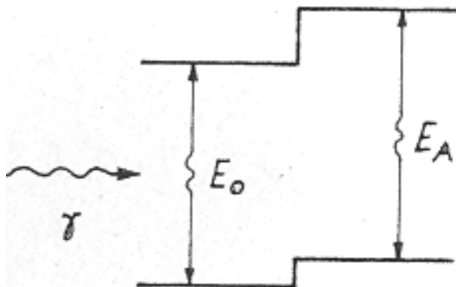
Effects

- Isomer Shift.
- Zeeman effect.

$$E = -g_N \mu_N B m_I$$

- Quadrapole.
- Temperature Shift.

$$\frac{\delta}{E} = \frac{v^2}{2c^2} = \frac{E_k}{mc^2}$$



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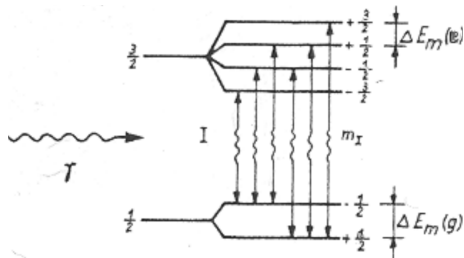
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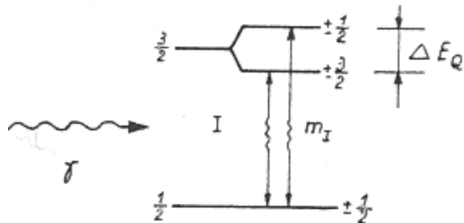
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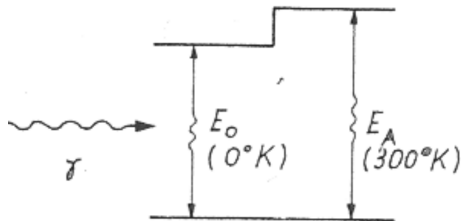
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Samples

- ^{57}Fe
- FeSO_4
- $\text{Fe}_2(\text{SO}_4)_3$
- Fe_2O_3
- Stainless steel (Varying temperature).
- $\text{Na}_4\text{Fe}(\text{CN})_6$ For line width.

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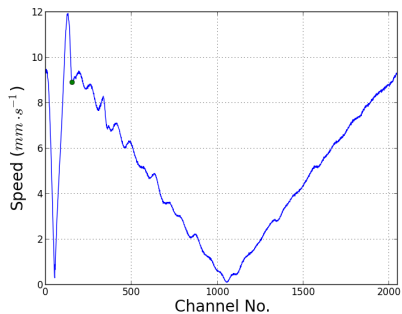
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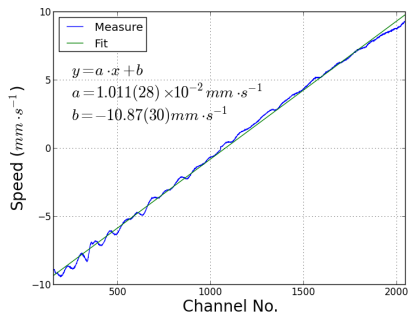
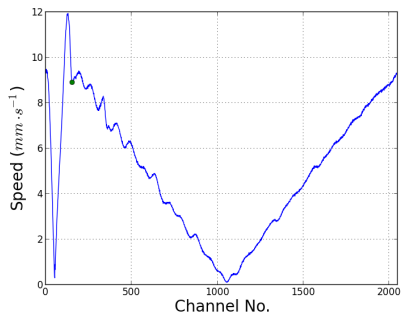
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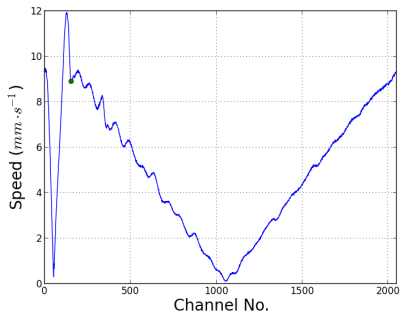
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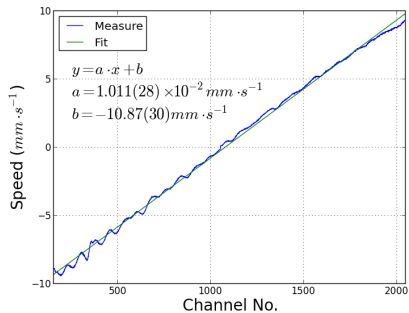
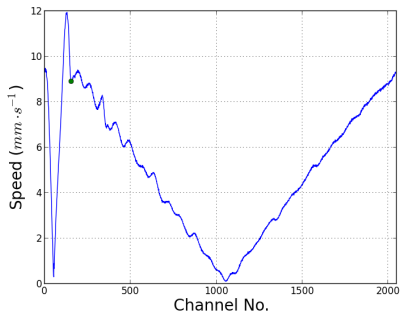
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Temperature effect.

Samples

- Classic:

$$E_k = \frac{3}{2}k_B T$$

- Debye T^3 approximation:

$$E_k = \frac{3\pi^4 * k_B * T^4}{10\Theta_D^3}$$

- Exact Debye Model:

$$E_k = \frac{9k_B T^4}{10\Theta_D^3} D_3 \left(\frac{T}{\Theta_D} \right)$$

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Model	E_k
Classic	$1.409(12) \cdot 10^{-2} eV$
Debye T^3	$4.59(22) \cdot 10^{-1} eV$
Exact Debye	$1.304(84) \cdot 10^{-2} eV$
(Measured)	$0.99(36) \cdot 10^{-2} eV$

Conclusion.

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- Measured Mössbauer spectrum of a variety of materials.
- Calculated different kinds of splitting and shifting.

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