Mössbauer Spectroscopy

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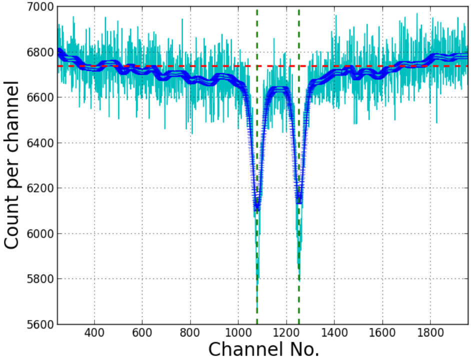
March 6, 2013

Mössbauer effect and Mössbauer spectroscopy.

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



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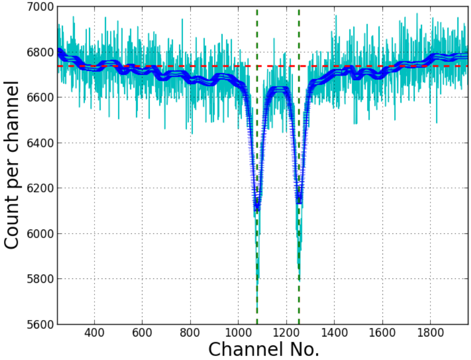

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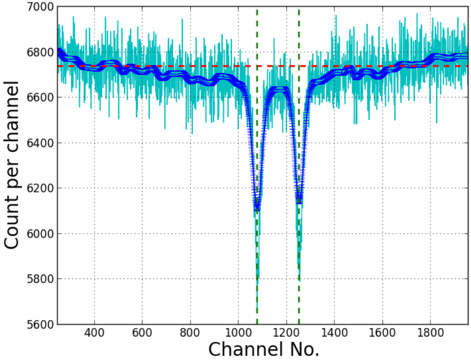

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1. **Mössbauer effect.**
2. **Apparatus and samples.**
3. **Data and result.**
4. **Conclusion.**

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- Radio active element radiate γ-ray at characteristic frequencies.
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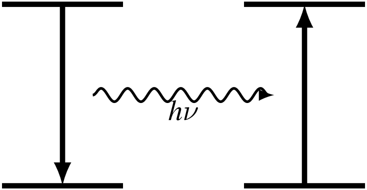

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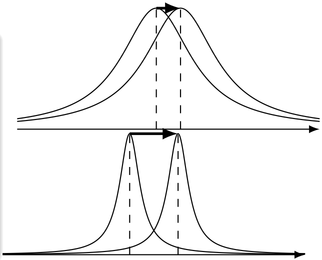

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- Momentum transfer with the whole cristal. $\rightarrow$ Recoilless.
- Scanning frequency using doppler effect.

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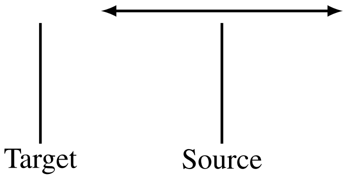

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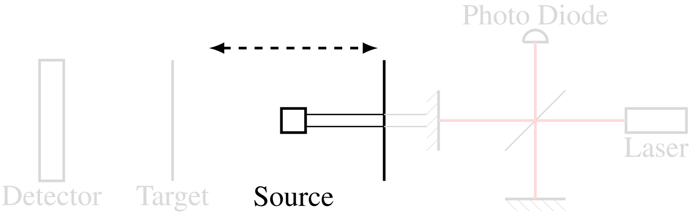

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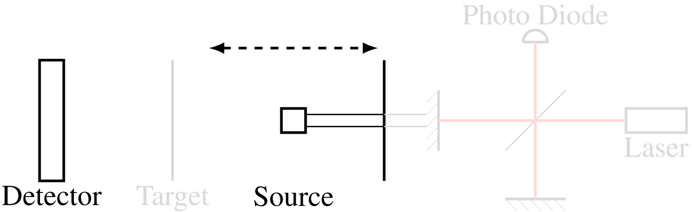

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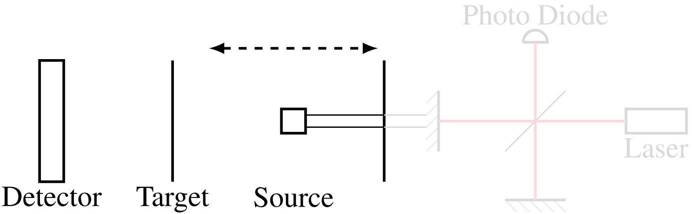

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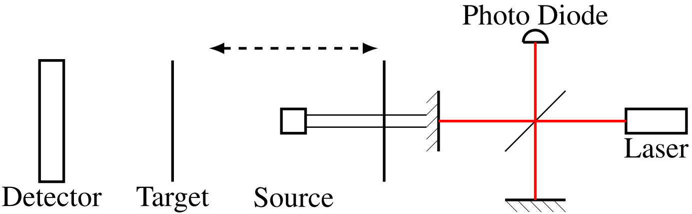


Effects and samples.

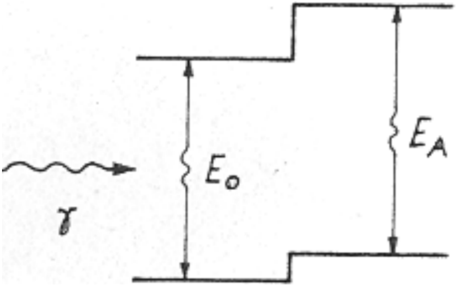
Effects

- 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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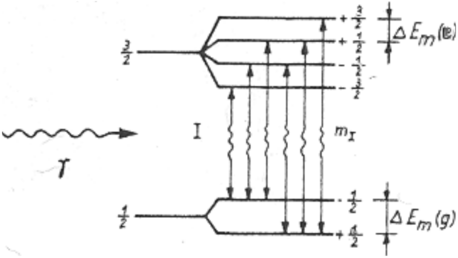

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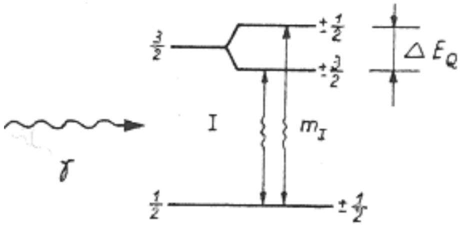

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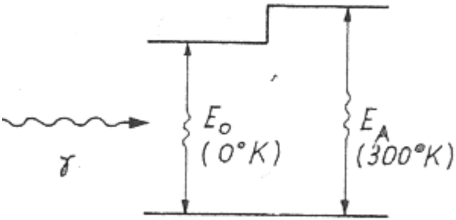

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Samples

- ^{57}Fe
- $FeSO_4$
- $Fe_2(SO_4)_3$
- Fe_2O_3
- Stainless steel (Varying temperature).
- $Na_4Fe(CN)_6$ For line width.

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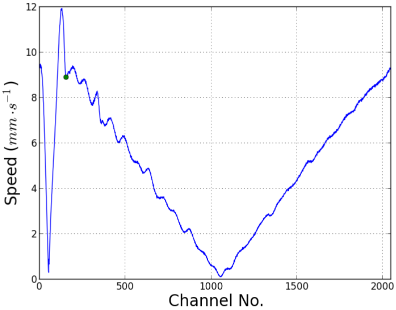

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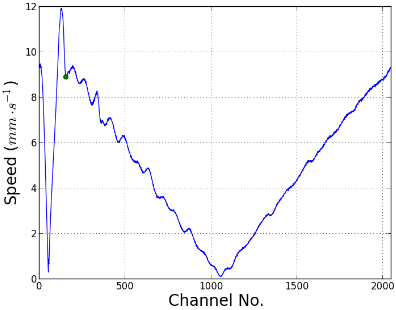

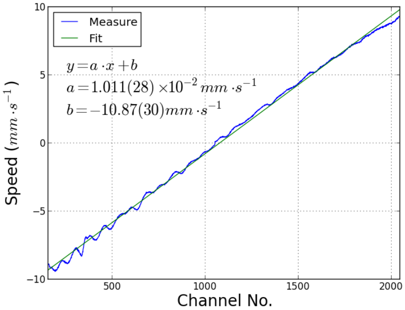

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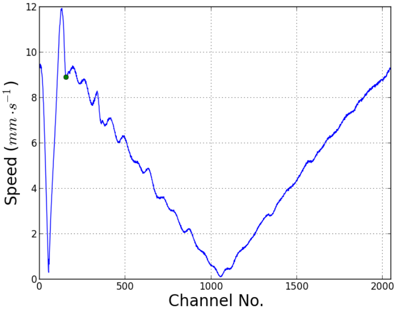
Speed ($mm \cdot s^{-1}$)
Channel No.
0
2
4
6
8
10
12
0
500
1000
1500
2000

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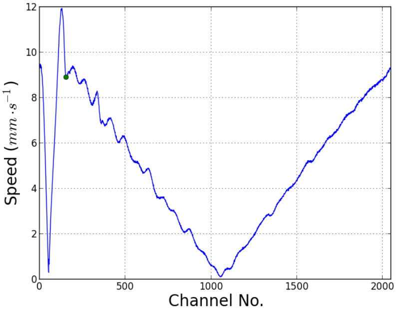

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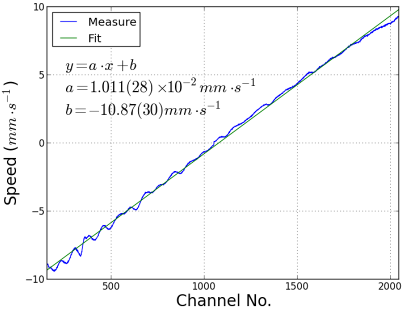

Measure
Fit
$y = a \cdot x + b$
$a = 1.011(28) \times 10^{-2}\, mm \cdot s^{-1}$
$b = -10.87(30) mm \cdot s^{-1}$
Speed ($mm \cdot s^{-1}$)
Channel No.

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:

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

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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.

- Calibrated the velocity using laser.
- Measured Mössbauer spectrum of a variety of materials.
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