

# Compton scattering

Vinh Tran

*Department of Physics and Kavli Institute for Astrophysics and Space Research,  
Massachusetts Institute of Technology, Cambridge, MA 02139, USA\**

(Dated: March 11, 2025)

## I. INTRODUCTION

## II. THEORY

### II.1. Inelastic scattering of photon

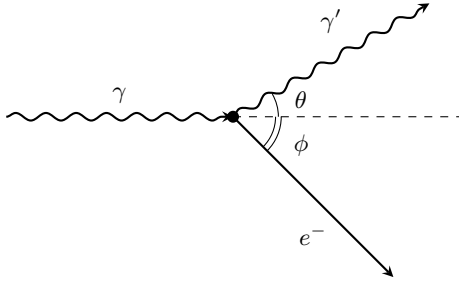


FIG. 1. Compton scattering of a photon by an electron.  $\gamma$  and  $\gamma'$  are the incident and scattered photons.  $e^-$  is the recoil electron initially at rest.  $\theta$  and  $\phi$  are the scattering and recoil angles, respectively.

Following relativistic kinematics, we treat photons as massless particles of energy  $E_\gamma = h\nu$ , where  $h$  is the Planck constant and  $\nu$  is the photon frequency. The energy of an electron is given by  $E_e = \sqrt{m_e^2 c^4 + p_e^2 c^2}$ , where  $m_e$  is the electron rest mass,  $p_e$  is the electron momentum, and  $c$  is the speed of light. By conservation of energy  $E$  and momentum  $\vec{p}$ , we have

$$E_\gamma + E_e = E'_\gamma + E'_e, \quad (1)$$

$$\vec{p}_\gamma + \vec{p}_e = \vec{p}'_\gamma + \vec{p}'_e, \quad (2)$$

where the prime denotes the final state. For simplicity, we take the initial electron energy as  $E_e = m_e c^2$ , that is the particle is initially at rest. Solving Equations (1) and (2), we obtain the energy of the scattered photon as

$$E'_\gamma = \frac{E_\gamma}{1 + \frac{E_\gamma}{m_e c^2} (1 - \cos \theta)}, \quad (3)$$

with  $\theta$  being the scattering angle, i.e. the angle between the initial and final photon momenta. The kinetic energy of the recoil electron is then approximated as  $E'_e = E_\gamma - E'_\gamma$ . The scattering scheme is illustrated in Figure 1.

$\theta$ [deg]	Counting Time [s]	Total Time [s]	Collection Date [YYYY-MM-DD]
0	964	1012	2025-03-04
30	1194	1224	2025-03-04
60	1619	1658	2025-03-04
90	1856	1900	2025-03-04
120	1706	1736	2025-03-04
15	1354	1522	2025-03-06
45	1333	1455	2025-03-06
75	1954	2058	2025-03-06
105	1645	1727	2025-03-06
135	1341	1431	2025-03-06

TABLE I.

### II.2. Differential cross section

### II.3. Total cross section & Attenuation

## III. EXPERIMENT SETUP

### III.1. Apparatus

### III.2. Data Collection

## IV. ANALYSIS & RESULTS

### IV.1. Energy-angle dependency

### IV.2. Scattering rate

## V. DISCUSSION & CONCLUSION

## ACKNOWLEDGMENTS

The author thanks his lab partner Y. Hu for collaboration in the experiment, support in the formatting and structuring of the manuscript. The author also thanks the JLab teaching staffs for their guidance and support, as well as the MIT Physics Department for providing the experimental apparatus.

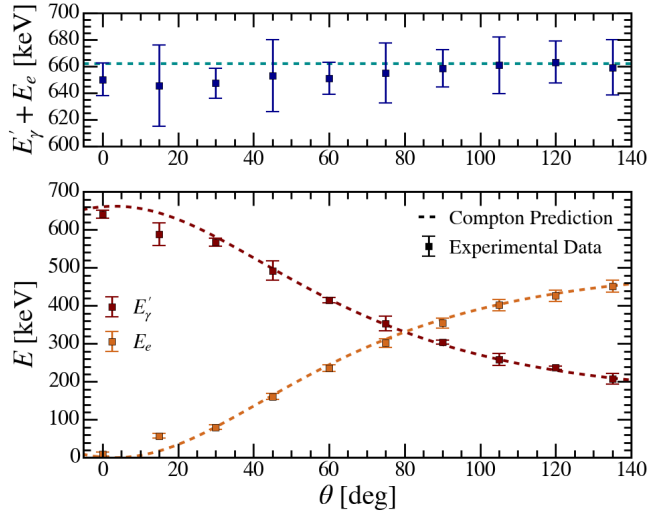


FIG. 2.

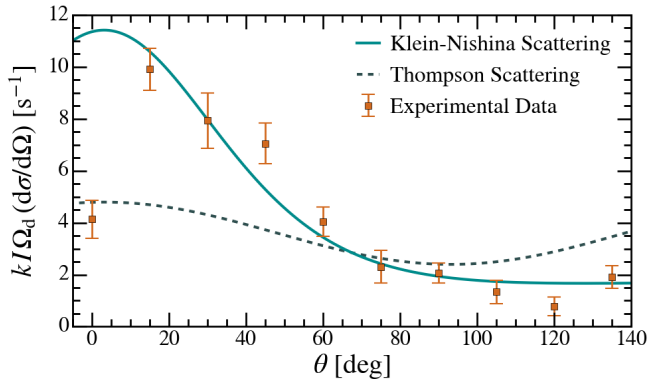


FIG. 3.

## Appendix A: Energy Calibration

---

\* [vinhtran@mit.edu](mailto:vinhtran@mit.edu)

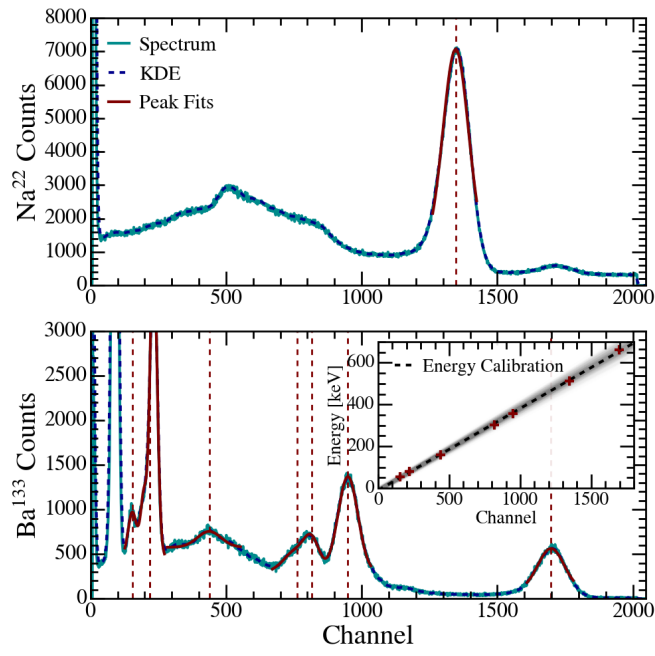


FIG. 4.