Prelim

**2. Introduction to PGNAA**

Prompt gamma-ray neutron activation analysis is a nondestructive, near real time technique used for bulk material identifications. PGNAA relies on neutron inelastic scatter and capture reactions to produce characteristic gamma-rays used to identify minute amounts of elements in a bulk sample. Due to low cross sections for these reactions, background sources from natural radiation, activation of the NaI detector, and gamma-rays from the decay of the neutron source a low signal to noise ratio (SNR) is common.

**2.1. Neutron Inelastic Scatter**

Neutron inelastic scatter involves an incoming neutron colliding with a target nucleus and exiting with less energy and at a different angle than it entered. The energy deposited on the target nucleus causes it to reach an excited state and rapidly releases a gamma-ray to return to its normal energy state represented in equation 1 as follows:

|  |  |  |
| --- | --- | --- |
|  |  | (1) |

**2.2 Neutron Capture**

Neutron capture, also denoted as (n, γ), can occur over a wide range of energies and has the highest probability at thermal energies for the elements of interst. The (n, γ) reaction begins when a neutron interacts with a target nucleus and is absorbed. The newly formed nucleus is placed in an excited state, and in order to form a new ground state, at least one γ photon is emitted as shown in eq. 2 below.

|  |  |  |
| --- | --- | --- |
|  |  | (2) |

Each nucleus (apart from Helium-4) gives off a distinct signature of intensities and energies, allowing for the identification of the sample from the γ photon emissions.