**Abstract**

We study the nuclear excitation spectra in the two energy domains: the low energy region (below 10 MeV) and giant resonance (GR) region (10-30 MeV). In the low energy region, we experimentally discovered an upbend in the radiative dipole strength function. This phenomenon can have a large impact on the rapid neutron capture cross sections, which is used, in particular, for the r-process nucleosynthesis.

The thermal continuum quasiparticle-random-phase approximation (TCQRP A) is one of the models which attempt to explain this phenomenon. The deficiency of TCQRP A is the absence of quasiparticle vibration coupling (QVC) mechanism, which is already included in relativistic time-blocking approximation (RTBA).

To obtain the E1 and M1 strength functions from the finite temperature RTBA model.

**Research Objectives**

1. To formulate finite temperature RTBA model.
2. To obtain the E1 and M1 strength functions from the finite temperature RTBA model.
3. To calculate the gamma strength function, rapid neutron capture reaction rates, possibly Gamow-Teller strengths, and beta decay rates relevant for r-process nucleosynthesis.

**Research Design**

**Mathieu Green's Function**

Constants

- \( \delta_{\alpha\beta} \) - Kronecker delta
- \( \delta_{T} \) - Dirac delta

Equations

- Free Emission
  \[ \rho_{\alpha\beta}(\omega) = \delta_{\alpha\beta} \delta_{T}(\omega) \]

- Free Absorption
  \[ \rho_{\alpha\beta}^{\text{abs}}(\omega) = \delta_{\alpha\beta} \delta_{T}(-\omega) \]

Deficiency: The absence of quasiparticle vibration coupling (QVC) mechanism, which is included in relativistic time-blocking approximation (RTBA).

**Preliminary Results**

Finite temperature B operator:

Free emission:

\[ \rho_{\alpha\beta}^{\text{em}}(\omega) = \frac{\delta_{\alpha\beta}}{\omega - \omega_{\alpha\beta}} \]

Free absorption:

\[ \rho_{\alpha\beta}^{\text{abs}}(\omega) = \frac{-\delta_{\alpha\beta}}{\omega + \omega_{\alpha\beta}} \]

**Status**

1. Direct application of the Mathieu Green's function for calculating operator \( B \) and mass operator shows promising results since it gives approximately the correct limit of 0.
2. There are still some unanswered questions related to the correct definition of finite temperature operator \( B \), such as the origin of factor 1/8 and the requirement to add minus sign so that it gives the correct limit for \( B \).

**Acknowledgments**

Herlik Wibowo acknowledges the tremendous support of Elena Litvinova as his supervisor and mentor in this research. He also acknowledges the Department of Physics Western Michigan University for his participation as one of the presenters in Eleventh Annual Research and Creative Activities Poster and Performance Day.