Quatum times and Bremsstrahlung in tunneling processes

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1. **Introduction**

Quantum tunneling phenomena is present in several scenerios, from nuclear physics to solid state physics, in this process particles with certain energy may be able to cross regions with potential energies higher than their actual energy, such process would be forbidden from a classical approach. During the process of tunneling the particle may suffer some kind of acceleration, therefore it should produce electromagnetic radiation. Even though this radiation can be measured there is no evidence of when and where the particle produced the radiation (the classical “forbidden zone” or after the particle has crossed the potential barrier). The understanding of this energy spectrum, given by the Bremmsstrahlung, might help us to comprehend the dynamics of these processes. This phenomena has been studied in alpha decay by several authors [1-6], however the results obtained have not shown a single behavior. One of the first, and most mentioned experimental results was obtained by D’Arrigo [2] with Ra 226 who considered a Coulomb barrier and stated that his results agreed with his model. Latter Kasagi [4] repeated the experiment with Po 210, with a semiclassical model, and found that his results where smaller than those obtained by D’Arrigo [2]. It’s important to mention that Boie [1] replicated the experiment done by Kasagi [4] and obtained better results fitting the model proposed by Kasagi [4]. In the theoretical manner we have two kinds of approximations, the first one is a semiclassical approach which have certain rules to be valid, this approach can be found in [3], the second one is a purely quantum mechanics method done by Papenbrok [6] with some simple potential that he defines. In [5] we are able to find a semiclassical approach with a more realistic nuclear potential that fits the behavior given by [6]. Results obtained by Kelkar [5] show that there are some effects that have been ignored.

1. **Boie**
2. **D’Arrigo**
3. **M.I. Dyakonov**
4. **Kasagi**
5. **Kelkar**
6. **Papenbrok**
7. **General objective**

* Study several tunneling time concepts in quantum mechanics and apply some of them to the study of Bremsstrahlung emission in tunneling.
* Investigate for Bremsstrahlung in several realistic scenarios.

1. **Specific Objectives**

* Apply the Bremsstrahlung process to the alpha decay process.
* Apply the Bremsstrahlung process to some other heavy particle emission.
* Investigate the Bremsstrahlung process due to an electron crossing a barrier.
* Repeat the process of the electron with a multibarrier potential.

1. **Methodology**

Exponer DETALLADAMENTE la metodología que se usará en la Monografía.

Monografía teórica o computacional: ¿Cómo se harán los cálculos teóricos? ¿Cómo se harán las simulaciones? ¿Qué requerimientos computacionales se necesitan? ¿Qué espacios físicos o virtuales se van a utilizar?

Theoretical part: At first I’m going to find a model which fits the Bremsstrahlung phenomena in the alpha decay experiment, latter this model will be aply to other scenarios with several numerical methods that will be designed in C and python. This models will be based, most of them, in the approach given by [6].

Monografía experimental: Recordar que para ser aprobada, los aparatos e insumos experimentales que se usarán en la Monografía deben estar previamente disponibles en la Universidad, o garantizar su disponibilidad para el tiempo en el que se realizará la misma. ¿Qué montajes experimentales se van a usar y que material se requiere? ¿En qué espacio físico se llevarán a cabo los experimentos? Si se usan aparatos externos, ¿qué permisos se necesitan? Si hay que realizar pagos a terceros, ¿cómo se financiará esto?

1. **Cronograma**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tareas \ Semanas** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** |
| 1 | X | X |  |  |  |  |  | X | X |  |  |  |  |  |  |  |
| 2 |  | X | X |  | X | X | X |  |  | X | X | X |  | X | X |  |
| 3 |  |  |  | X |  |  |  | X |  |  |  | X |  |  | X |  |
| 4 | X | X | X | X | X | X | X | X | X | X |  |  |  |  |  |  |
| 5 |  |  |  |  | X | X | X |  |  |  |  | X | X | X | X | X |

* Tarea 1: Descripción de la tarea 1
* Tarea 2: Descripción de la tarea 2
* Tarea 3: Descripción de la tarea 3

1. **Personas Conocedoras del Tema**

Nombres de por lo menos 3 profesores que conozcan del tema. Uno de ellos debe ser profesor de planta de la Universidad de los Andes.

* Nombre de profesor 1 (Instituto o Universidad de afiliación 1)
* Nombre de profesor 2 (Instituto o Universidad de afiliación 2)
* Nombre de profesor 3 (Instituto o Universidad de afiliación 3)

1. **Referencias**
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5. Stefanov , N. Gisin , O. Guinnard , L. Guinnard y H. Zbinden. Journal of Modern Optics, **47**: 4, 595-598, (2000).

**Firma del Director**

**Firma del Codirector**