Rapid proton capture process in type I X-ray bursts generated in LMXBs with the effects of nuclear masses

Master's Thesis, 2.9.2025

Author:

Antero Voutilainen

Supervisor:

ANU KANKAINEN MIIKKA WINTER



This publication is copyrighted. You may download, display and print it for Your own personal use. Commercial use is prohibited. Julkaisu on tekijänoikeussäännösten alainen. Teosta voi lukea ja tulostaa henkilökohtaista käyttöä varten. Käyttö kaupallisiin tarkoituksiin on kielletty.

Abstract

Voutilainen, Antero

Rapid proton capture process in type I X-ray bursts generated in LMXBs with the effects of nuclear masses

Master's thesis

Department of Physics, University of Jyväskylä, 2025, ?? pages.

Keywords: Thesis, abstract, writing, instructions

Tiivistelmä

Voutilainen, Antero Rapid proton capture process in type I X-ray bursts generated in LMXBs with the effects of nuclear masses Pro gradu -tutkielma Fysiikan laitos, Jyväskylän yliopisto, 2025, ?? sivua

Avainsanat: Opinnäyte, tiivistelmä, kirjoittaminen, ohjeet

Preface

Jyväskylä January 1, 2020

Olli Opiskelija

Contents

1 Introduction

2 Theoretical background

- 2.1 Low Mass X-ray Binaries
- 2.1.1 Nuclear reaction network
- 2.1.2 Rapid Proton Capture Process
- 2.1.3 Total Reaction Rate

Total reaction rate:

$$N_{A}\langle \sigma v \rangle_{total} = \sum_{i} N_{A}\langle \sigma v \rangle_{narrow \ resonances}^{i}$$

$$+ \sum_{k} N_{A}\langle \sigma v \rangle_{broad \ resonances}^{k}$$

$$+ N_{A}\langle \sigma v \rangle_{non \ resonant}$$

$$+ N_{A}\langle \sigma v \rangle_{continuum}$$

$$(1)$$

- 2.1.4 Light Emission Curves
- 2.2 TALYS
- 2.2.1 Hauser-Feshbach statistical model
- 2.2.2 Parameters
- 2.3 Winnet
- 3 Methods and materials
- 3.1 Nuclear masses measured at IGISOL
- 3.2 Usage of TALYS
- 3.3 Usage of Winnet
- 3.4 Simulation of Light Curves
- 4 Results
- 4.1 Simulated Light Curves
- 5 Conclusions

A First appendix

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.

B Second appendix

Nam dui ligula, fringilla a, euismod sodales, sollicitudin vel, wisi. Morbi auctor lorem non justo. Nam lacus libero, pretium at, lobortis vitae, ultricies et, tellus. Donec aliquet, tortor sed accumsan bibendum, erat ligula aliquet magna, vitae ornare odio metus a mi. Morbi ac orci et nisl hendrerit mollis. Suspendisse ut massa. Cras nec ante. Pellentesque a nulla. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus. Aliquam tincidunt urna. Nulla ullamcorper vestibulum turpis. Pellentesque cursus luctus mauris.

Nulla malesuada porttitor diam. Donec felis erat, congue non, volutpat at, tincidunt tristique, libero. Vivamus viverra fermentum felis. Donec nonummy pellentesque ante. Phasellus adipiscing semper elit. Proin fermentum massa ac quam. Sed diam turpis, molestie vitae, placerat a, molestie nec, leo. Maecenas lacinia. Nam ipsum ligula, eleifend at, accumsan nec, suscipit a, ipsum. Morbi blandit ligula feugiat magna. Nunc eleifend consequat lorem. Sed lacinia nulla vitae enim. Pellentesque tincidunt purus vel magna. Integer non enim. Praesent euismod nunc eu purus. Donec bibendum quam in tellus. Nullam cursus pulvinar lectus. Donec et mi. Nam vulputate metus eu enim. Vestibulum pellentesque felis eu massa.