Durham University

EXAMINATION FOR RESEARCH DEGREES

Examiners' Joint Report

Name of Candidate: Mr Matheus Hostert
Banner ID: 000605447
Degree for which Candidate is registered: DOCTOR OF PHILOSOPHY
Title of Thesis: Hidden Physics at the Neutrino Frontier; Tridents, Dark Forces and Hidden Particles
Name of Internal Examiner: Dr David Cerdeno
Name of External Examiner: Dr Joachim Kopp

You should complete the joint report and recommendation together immediately after the oral examination or after conferral when an oral examination is not required, and return the typed, signed report to the Curriculum, Learning & Assessment Service **within five working days**.

You should attach to this joint report any material concerning minor corrections or requirements for resubmission, for transmission to the candidate.

The candidate has presented the results of the thesis. The candidate has responded to the all the questions and comments posed by both examiners, giving evidence that the thesis is his own work. The quality of the work presented was of a high standard and his contribution to this area of knowledge is original and relevant.

We recommend that the candidate be admitted to the degree of PhD after the following minor corrections are included in the thesis.

Minor Corrections:

- Page 16: When mentioning the Higgs mechanism, we suggest to also add references to the work of Englert and Brout.
- Chapter 3: Add a brief comment about the validity of the Woods-Saxon form factors and whether uncertainties in the nuclear form factor can affect the results of the study.
- Page 73: The statement in the last paragraph "Although the number of trident events [...] is rather low, they may offer one of the first opportunities to study trident events [...]" is a bit misleading and could be rewritten. According to table 3.2 the number of expected events is of the order of 10, probably insufficient to study trident physics in itself (although useful to set constraints and do some other studies).
- Page 74: remind the reader what the exposure of nuSTORM – it appears in page 77 but by then the readedr has already seen table 3.4.

- Page 79: In table 3.3 and in the text, the misID uncertainty is set to 10% for pions. Comment on how realistic this number is and, if it can increase or decrease, mention (briefly and only qualitatively) the effect it might have on the results.
- Section 3.2: we suggest that the candidate comments on the reason that deep inelastic scattering does not need to be considered in the discussion of neutrino trident production.
- Section 3.2: We suggest a comment on the absence of a magnetic moment interaction in the coherent regime, which is valid for spin-0 nuclei like Ar-40, but not for nuclei carrying magnetic moments.
- Chapter 4: There are various places where the candidate mentions the predictions for tridents in DUNE and cites reference [1]. To give the thesis more cohesion we suggest that the candidate cross-references Section 3 of his thesis, where the work of reference [1] is reported. This happens, e.g. in page 86 and 96.
- Section 5.2.2: Since this section mentions the possibility of having a dark matter candidate in the model, we suggest that the candidate comments on the different possibilities to reproduce the correct relic density.
- Sections 7.1 and 7.3: the estimate for the size of the neutrino wave packets is problematic. While it is difficult to come up with a precise estimate for this quantity, it is very likely smaller than the size of the decay region. Rather, the neutrino will most likely inherit the localization of its parent particles. We suggest that the candidate comments on this problem and discusses the impact of a smaller wave packet size on his results.

Joint Recommendation – Mr Matheus Hostert:
Guidance on completing this form can be found at: http://www.dur.ac.uk/learningandteaching.handbook/8/6/3/

		(tick)
The candidate be admitted to the degree of PHD:		
A	PASS (Unconditionally)	
B	PASS (with Minor Corrections) Minor Corrections are defined as changes that do not require the candidate to undertake substantial further work (e.g. typographical errors, clarifying points, rephrasing, editing/adding paragraphs, correcting references etc), and should be used where the thesis does not require re-examination to ensure that it fulfils the criteria for the award. Such changes should be specified by the Examiners and subsequently approved by the Internal Examiner, normally within **3 months**	X
C	PASS (with Major Corrections) Major Corrections are defined as changes that require the candidate to undertake further work of greater substance (e.g. more extensive editorial changes, the addition of more substantial material, rewriting of larger passages etc), but where the thesis does not require re-examination to ensure that it fulfils the criteria for the award. Such changes should be specified by the Examiners and subsequently approved by the Internal Examiner, normally within **6 months.**	
The candidate be NOT ADMITTED to the degree of PHD:		
D	The candidate should re-submit the thesis in a revised form, within a 12 month period. In this case changes are deemed substantive in nature (which may requiring require the candidate to conduct further research and/or analysis) and/or where the thesis requires full re-examination by both examiners to ensure that it fulfils the criteria required for the award. Examiners should identify required changes in their joint report. The candidate will be registered for a further period of 12 months' continuation, and will resubmit two soft-bound copies of their thesis. These will be re-examined by the examiners, who may request a second viva if necessary.	
The candidate be admitted to a LOWER DEGREE (if applicable):		
E	That the LOWER degree of .....* be awarded unconditionally	
F	That the LOWER degree of .....* be awarded after minor/major corrections *Minor and Major corrections* are defined above under 'B' and 'C'	
The candidate be NOT ADMITTED to a LOWER DEGREE (if applicable):		
G	The candidate should re-submit the thesis in a revised form, within a **12 month** period for a lower degree. **The candidate should re-submit the thesis in a revised form within ..... months for the LOWER degree of.....*.** *Resubmission* is defined above under 'D'	
H	That the candidate be deemed to have FAILED outright	

* Please insert Degree i.e. MPhil, MLitt, MMus, MEd, MTheo, MJur, MA or MSc. Examiners should refer to the criteria for research degree awards: http://www.dur.ac.uk/resources/university.calendar/volumeii/2011.2012/coreregsrdtc.pdf

Signed Internal Examiner (Dr David G. Cerdeño): **Date: 4/9/2019**

Signed External Examiner (Dr Joachim Kopp): **Date: 4/9/2019**

For Office Use Only: Recommendation approved on behalf of FEC (PG):

Signature: Date: 16 Sept '19

Issues to note ☐ .....

Durham University, Research Degree Examination Process.
Guidance: http://www.dur.ac.uk/learningandteaching.handbook/8/6/
Contact: pg.admin@durham.ac.uk