

# Direct Empirical Status of Theoretical Symmetries in Physics

Thèse réalisée par  
**Valeriya CHASOVA**

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**Membres du jury :**

Alexandre GUAY (UCLouvain), promoteur et secrétaire du jury

Michel GHINS (UCLouvain), lecteur

Guido BACCIAGALUPPI (Utrecht University, Pays-Bas), lecteur extérieur

Simon FRIEDERICH (University of Groningen, Pays-Bas), lecteur extérieur

Jean-Michel COUNET (UCLouvain), président

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## Contents

**Acknowledgements** – p. 7

**Summary** – p. 7

**Part I. Ontology of theoretical symmetries in physics** – p. 8

Chapter I. 1. Ontology and science – p. 8

*Section I. 1. 1. Ontology and epistemology* – p. 8

*Section I. 1. 2. Ontology of science* – p. 9

*Section I. 1. 3. The NMA, the PMI and the 'partwise' approach to the ontology* – p. 11

Chapter I. 2. Different contexts of study of the ontology of theoretical symmetries in physics – p. 13

*Section I. 2. 1. Constituents of a symmetry* – p. 13

*Section I. 2. 2. Spacetime symmetries* – p. 16

*Subsection I. 2. 2. 1. Leibniz versus Newton and Clarke* – p. 16

*Subsection I. 2. 2. 2. Earman and Norton versus Maudlin* – p. 17

*Section I. 2. 3. Similar objects* – p. 20

*Subsection I. 2. 3. 1. Permutations of 'indistinguishable' objects* – p. 20

*Subsection I. 2. 3. 2. Objects with spatiotemporal differences* – p. 23

*Subsection I. 2. 3. 3. Objects with non-spatiotemporal differences* – p. 24

*I. 2. 4. Ontology of gauge symmetries* – p. 27

*Subsection I. 2. 4. 1. What are gauge symmetries* – p. 27

*Subsection I. 2. 4. 2. The gauge principle* – p. 28

*Subsection I. 2. 4. 3. The gauge argument* – p. 30

*I. 2. 5. Indirect empirical status (IES)* – p. 32

*Subsection I. 2. 5. 1. Hamilton's principle and Noether's theorems* – p. 33

*Subsection I. 2. 5. 2. Ontology of symmetries of actions* – p. 34

Chapter I. 3. A brief presentation of direct empirical status (DES) – p. 37

**Part II. Presentation and analysis of the main literature on direct empirical status** – p. 42

Chapter II. 1. Kosso [2000] – p. 42

*Section II. 1. 1. Brief summary of the text* – p. 42

*Section II. 1. 2. Extended summary of the text* – p. 42

*Section II. 1. 3. A critical analysis* – p. 47

*Subsection II. 1. 3. 1. Positive aspects and importance* – p. 47

*Subsection II. 1. 3. 2. The physical level: problems with the active/passive distinction* – p. 48

*Subsection II. 1. 3. 3. The theoretical level: problems with the global/local and the internal/external distinctions* – p. 50

*Subsection II. 1. 3. 4. DES: unwarranted generalisations, mixed levels and missing conditions* – p. 51

*Subsection II. 1. 3. 5. The two approaches* – p. 54

*Section II. 1. 4. Brief summary of the analysis* – p. 55

Chapter II. 2. Brading and Brown [2004] – p. 51

*Section II. 2. 1. Brief summary of the text – p. 56*

*Section II. 2. 2. Extended summary of the text – p. 56*

*Section II. 2. 3. A critical analysis – p. 69*

*Subsection II. 2. 3. 1. The physical level: the three traits – p. 69*

*Subsection II. 2. 3. 2. DES and the two approaches – p. 71*

*Subsection II. 2. 3. 3. 't Hooft's beam-splitter case: specific claims – p. 74*

*Subsection II. 2. 3. 4. 't Hooft's beam-splitter case: some global/local distinctions – p. 74*

*Subsection II. 2. 3. 5. 't Hooft's beam-splitter case: the distinction between subsystems and their parts and the universal/restricted distinction – p. 79*

*Subsection II. 2. 3. 6. 't Hooft's beam-splitter case: the observable difference condition and the observable invariance condition – p. 85*

*Subsection II. 2. 3. 7. 't Hooft's beam-splitter case: the matchings and DES reconsidered – p. 89*

*Subsection II. 2. 3. 8. 't Hooft's beam-splitter case: theoretical transformations, symmetries and states – p. 91*

*Subsection II. 2. 3. 9. DES of external global symmetries and the non-triviality check for empirical symmetries – p. 93*

*Subsection II. 2. 3. 10. DES of external local symmetries and Einstein's elevator empirical symmetry – p. 96*

*Section II. 2. 4. Summary of the analysis – p. 101*

Chapter II. 3. Healey [2009] – p. 102

*Section II. 3. 1. Brief summary of the text – p. 102*

*Section II. 3. 2. Extended summary of the text – p. 102*

*Section II. 3. 3. Analysis of the text – p. 114*

*Subsection II. 3. 3. 1. Book versus article – p. 114*

*Subsection II. 3. 3. 2. Kinds of DES – p. 115*

*Subsection II. 3. 3. 3. Healey's weaker DES: observable invariance – p. 116*

*Subsection II. 3. 3. 4. A weak strengthening of Healey's weaker DES: observable differences – p. 119*

*Subsection II. 3. 3. 5. Healey's stronger DES: unobservable intrinsic properties – p. 123*

*Subsection II. 3. 3. 6. Healey's key argument: a failure – p. 126*

*Subsection II. 3. 3. 7. Healey's key argument: a replacement – p. 130*

*Subsection II. 3. 3. 8. Representing Faraday's cage empirical symmetry: Healey's specific claims – p. 134*

*Subsection II. 3. 3. 9. Representing Faraday's cage empirical symmetry: alternatives – p. 139*

*Subsection II. 3. 3. 10. Strengthening DES further and the ontology – p. 142*

*Section II. 3. 4. Summary of the analysis – p. 145*

Chapter II. 4. Greaves and Wallace [2014] – p. 145

*Section II. 4. 1. Brief summary of the text – p. 145*

*Section II. 4. 2. Extended summary of the text – p. 146*

*Section II. 4. 3. Analysis of the text – p. 159*

*Subsection II. 4. 1. 1. Positive aspects and importance – p. 159*

*Subsection II. 4. 1. 2. Problems with justifying Greaves and Wallace's assignments of DES – p. 160*

*Subsection II. 4. 1. 3. What is unsatisfactory about Greaves and Wallace's framework – p. 164*  
*Section II. 4. 4. Summary of the analysis – p. 167*

**Part III. My own account of direct empirical status – p. 169**

Chapter III. 1. Formalising the notion of empirical symmetry – p. 169

*Section III. 1. 1. Identifiability – p. 169*

*Section III. 1. 2. Points of view, observers and references – p. 173*

*Section III. 1. 3. Physical features – p. 177*

*Section III. 1. 4. Definition of a generic empirical symmetry – p. 180*

*Section III. 1. 5. Microscopic empirical symmetries and Wu-Yang's beam-splitter empirical symmetry – p. 181*

*Section III. 1. 6. Specifications to the recognised empirical symmetries, to their realisations and to their instances – p. 183*

*Section III. 1. 7. The equivalence of the two ways of realising empirical symmetries – p. 186*

Chapter III. 2. The matching relationships – p. 187

*Section III. 2. 1. Ladyman and Presnell's kinds of DES versus my kinds of DES – p. 187*

*Section III. 2. 2. The theoretical approach versus the empirical approach – p. 190*

Chapter III. 3. Theoretical symmetries with the observational DES in the empirical approach – p. 192

*Section III. 3. 1. A strengthened observational DES in the empirical approach – p. 192*

*Section III. 3. 2. Representing a physical state of an observable empirical symmetry – p. 193*

*Section III. 3. 3. The proliferation of representations of physical states – p. 195*

*Section III. 3. 4. Representing the possible physical transformation of an observable empirical symmetry – p. 196*

*Section III. 3. 5. Consequences for the literature on DES – p. 198*

Chapter III. 4. Global and local transformations and states – p. 199

*Section III. 4. 1. Which global/local distinction for theoretical transformations is possibly relevant to DES – p. 199*

*Section III. 4. 2. Extension to a possibly relevant global/local distinction for theoretical states – p. 202*

*Section III. 4. 3. Given and constructed theoretical transformations, states and symmetries – p. 205*

Chapter III. 5. Why would one attribute DES to (properly) global symmetries alone – p. 206

*Section III. 5. 1. A critique of the traditional attributions of DES to global symmetries alone – p. 207*

*Section III. 5. 2. A reformulation of the nuanced traditional position – p. 208*

*Section III. 5. 3. Why would one support the reformulated nuanced traditional position – p. 211*

Chapter III. 6. Constructing more theoretical symmetries with the observational DES – p. 213

*Section III. 6. 1. How the proof works – p. 213*

*Section III. 6. 2. The proof* – p. 215

Chapter III. 7. Consequences of the proof – p. 221

**Conclusion** – p. 224

**References** – p. 228

**Appendix** – p. 233

Setups of 't Hooft's beam-splitter empirical symmetry – p. 233

Table: The recognised empirical symmetries – p. 234

Figures for the proof – p. 236

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## Summary

The work provides a novel ontological analysis of direct empirical status (DES), i.e. of the relationship between theoretical symmetries from physics and empirical symmetries, where the latter are symmetries in the world similar to Galileo's ship thought experiment.

Part I explains why study the ontology of theoretical symmetries in physics in general, provides a survey of some of the usual ways of studying that topic and presents DES briefly in that context. Part II recounts and analyses in detail the four main texts on DES, namely [Kosso 2000], [Brading and Brown 2004], [Healey 2009] and [Greaves and Wallace 2014], and provides some details of my own account of DES. Part III presents my account in more generality and more fully, explaining in particular how to formalise the notion of empirical symmetry, why use the empirical approach rather than the theoretical approach when establishing DES, what theoretical symmetries with the observational DES look like in the empirical approach, whether the global/local distinction matters for DES and how gauge symmetries in the sense of observationally complete theoretical symmetries are linked with DES.

What follows from my account is that empirical symmetries mostly have relational nature and need references to be established; that there is an infinity of properly global, properly local and mixed theoretical symmetries which have the observational DES with respect to a given empirical symmetry; and that which theoretical symmetries have a stronger ontological DES may depend on whether gauge symmetries in the sense above have an independent ontological significance, i.e. match with unobservable transformations and differences in the world.

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