The Life-Cycles of Scientific Principles

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Aim

- Understanding scientific principles in their development.
- Identifying relevant features a principle may or may not acquire in the development
- Prospect: Explore the extent to which these features may provide the explanatory framework within which to understand the role a scientific principle may play.

Features in the Development of a Scientific Principle

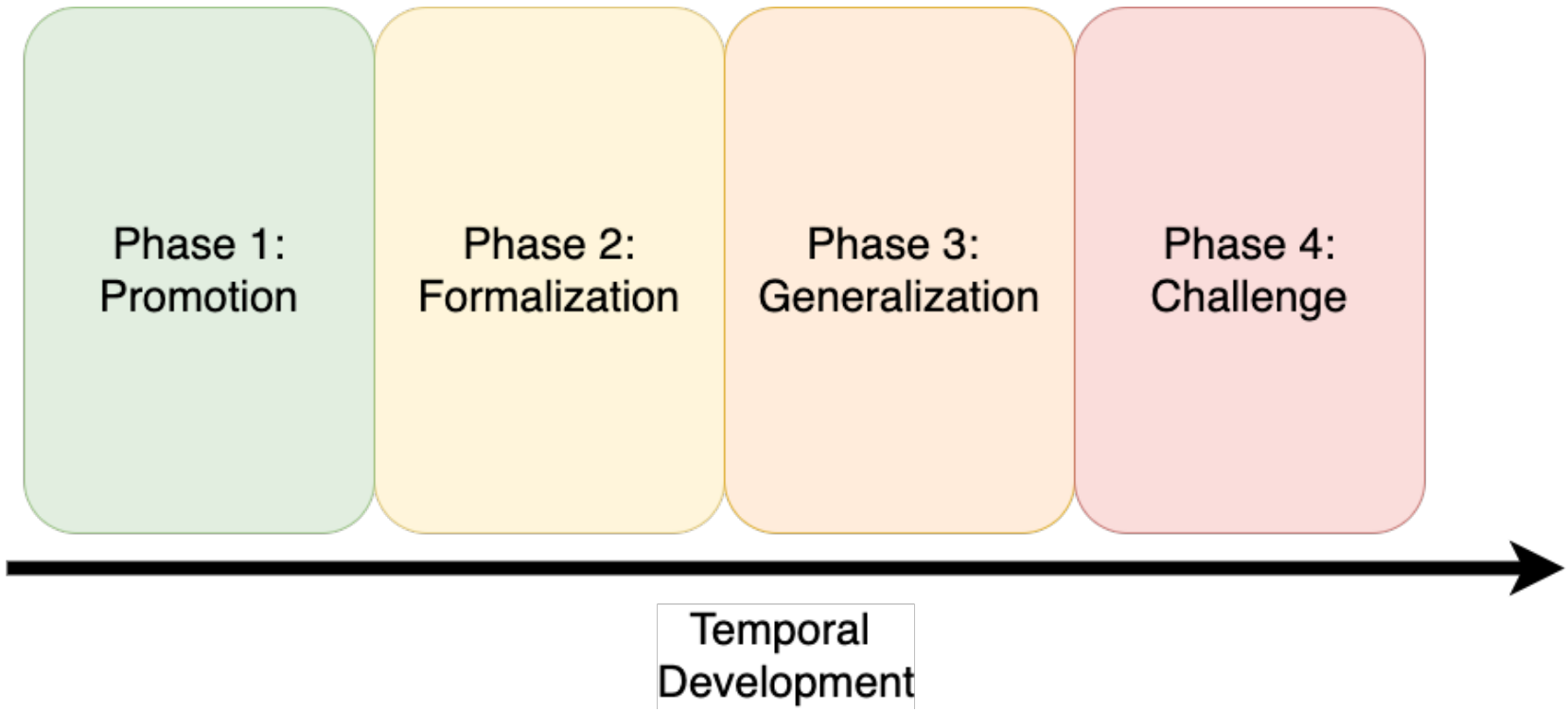
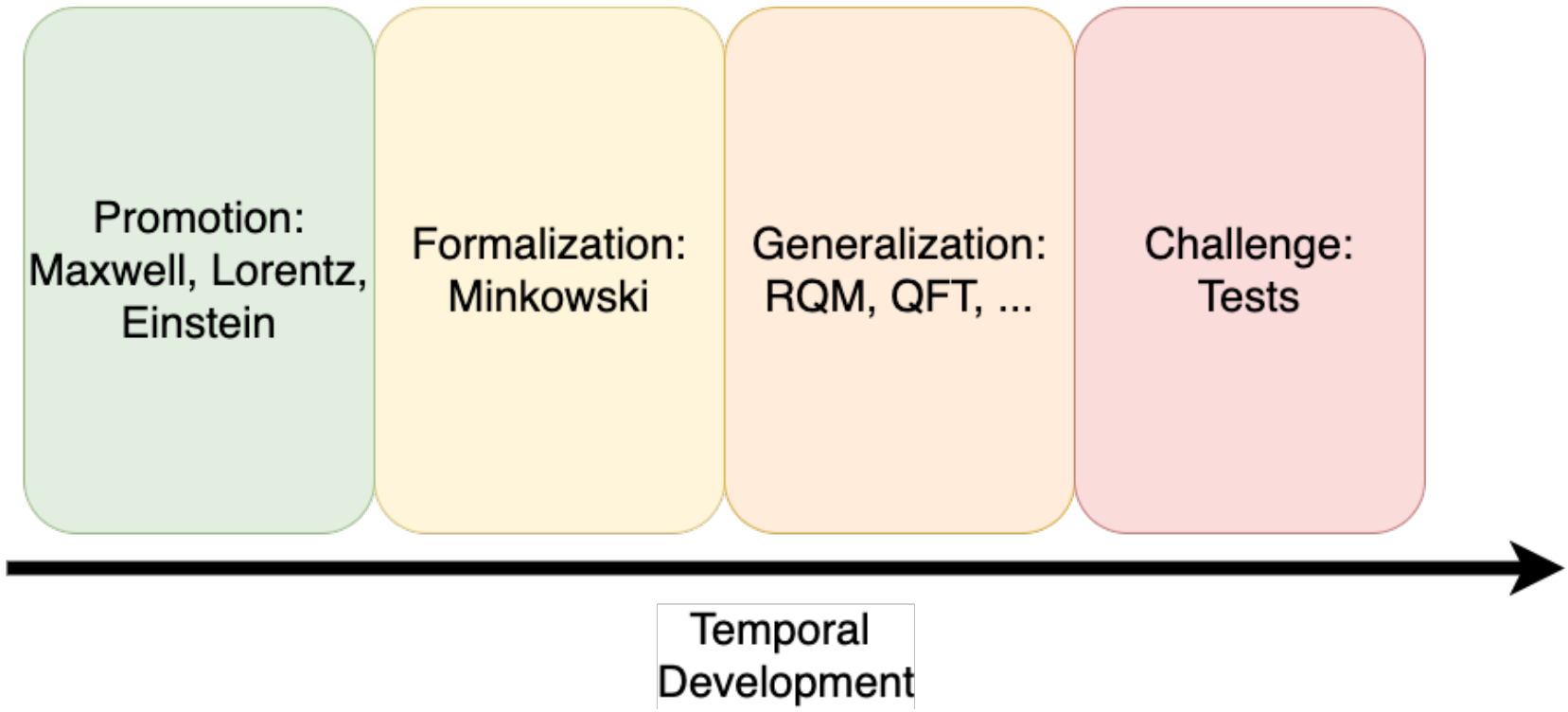


Illustration: Lorentz Invariance



Phase 1: Promotion

- Reasons for promotion
  - increase in explanatory coherence
  - metaphysical justification
  - empirical justification
  - meta-inductive justification
  - combination of the above

- Kinds of promotion
  - A principle gains some kind of priority over other features of the theory
  - Various kinds of conventionalism (LeRoy, Poincaré)
  - Relativistic a priori (Friedmann)
  - unanimity among scientists not necessary

Phase 2: Formalization

The formal aspect of a principle may be implemented in different ways and to various degrees of sophistication

- Principle enforced by a mathematical condition (e.g. Bohr's correspondence principle)
- Set of rules to ensure the principle (renormalizability)
- Mathematical formalism (e.g. Minkowski spacetime, four-vector formalism)
- Physical formalism: framework theory that allows to ensure the principle from the get-go (e.g. unitarity in QFT)

Phase 3: Generalization

- domain-specific generalization
  - From Pauli to Spin-statistics
  - From $m_G = m_I$ to the equivalence principle
- domain-extended generalization
  - From the classical to the quantum realm (e.g. Lorentz invariance)
  - From a lower to a higher energy scale (e.g. naturalness)
  - From one set of entities to others (Pauli principle: from electrons to quarks)

Phase 4: Challenge

- Experimental challenges
  - perfect cosmological principle
- Theoretical challenges
  - minimal length scale in QG
- Testing the viability for future model building (LIV).

Prospect

Starting point: scientific principles go through certain phases and acquire certain features in their development.

Aim: Explore the relation between the features a principle has acquired (or possibly can't acquire) and the role that principles can play in scientific practice.