Forces Are Not Invariants

Amos Jay Maley

Abstract

It is commonly assumed that fundamental forces correspond to invariant features of physical reality. In this paper, we show that this assumption cannot be sustained. Treating forces as invariants leads either to redundancy in constraint imposition or to hidden nonlocal dependence incompatible with locality. We argue that forces should instead be understood as representational artifacts arising from particular local descriptions, rather than as invariant structures. The result is eliminative: no alternative ontology of forces is proposed, only the conclusion that force realism is untenable.

1 Introduction

In contemporary physical discourse, forces are routinely treated as fundamental constituents of reality. They are spoken of as entities or mechanisms that exist independently of description and that govern the behavior of physical systems. This realist treatment is rarely examined explicitly; instead, it is inherited tacitly from historical formulations and pedagogical convention.

This paper asks a limited but precise question:

> What would it mean for a force to be an invariant?

We show that once this question is taken seriously, the concept of a force as an invariant feature of reality collapses. The problem is not empirical adequacy, nor explanatory power, but internal coherence. If a force is treated as invariant, it must satisfy minimal structural requirements of invariance and locality. We show that it cannot do so without contradiction.

The argument is eliminative rather than constructive. We do not propose a replacement theory of forces, nor do we advance a novel physical framework. Our aim is only to demonstrate that force realism is not a coherent position once basic structural constraints are enforced.

2 What Counts as an Invariant

We begin by clarifying what is meant by an invariant in the present context.

An invariant is a structure that:

1. persists across admissible re-descriptions of a system,
2. does not depend on representational choices such as coordinates, gauges, or parameterizations,

3. constrains physical possibilities rather than merely tracking them.

In this paper, "invariant" is used in a minimal structural sense: a feature is invariant if it constrains physical possibilities independently of representational choice and persists under admissible re-descriptions of a system. No specific mathematical symmetry group is presupposed, nor is observer-dependence the central issue. The question at stake is whether forces can function as representation-independent constraints.

If forces are to be treated as invariants, they must satisfy these criteria. In particular, they must not depend on how a system is represented locally, nor may they introduce additional structure that is not itself invariant.

3 The Constraint Duplication Problem

Physical locality imposes structural constraints on admissible descriptions: it restricts how dependencies may be represented without invoking global coordination. Any acceptable physical description must already satisfy these constraints. The question, then, is whether forces introduce additional, independent constraints beyond those already imposed by locality.

If a force is invariant, two possibilities arise:

1. The force imposes constraints already required by locality.

2. The force imposes additional constraints beyond locality.

In the first case, the force is redundant. It duplicates structural constraints without adding explanatory or representational necessity. Redundant constraint structures are not characteristic of genuine invariants.

In the second case, the force introduces additional structure that must be coordinated across local descriptions. Such coordination cannot be achieved through purely local relations and therefore conflicts with locality.

Thus, treating forces as invariants leads either to redundancy or to violation of locality.

4 Invariant Forces and Hidden Global Dependence

One might attempt to rescue force realism by insisting that forces are both invariant and local. This move is common in informal discourse, particularly in field-theoretic contexts.

However, invariance imposes additional requirements. For a force law to be invariant, its form must be fixed across all admissible local descriptions. Maintaining this fixity requires consistency conditions that relate distinct local descriptions to a single globally specified structure.

The issue here is not action-at-a-distance, but global consistency. These consistency conditions are not themselves local relations; they presuppose that local descriptions conform to a globally fixed structure. This introduces hidden global dependence: the behavior within a local description is constrained by requirements defined outside that description.

Accordingly, the notion of a *local invariant force* is internally inconsistent. Locality and invariance cannot both be satisfied by forces construed as ontic entities.

5 Forces as Representational Artifacts

The preceding contradictions dissolve if forces are not treated as invariants. Instead, forces may be understood as representational artifacts: structures that arise within particular local descriptions to track constraint relations.

On this view:

- forces do not exist independently of description,
- different formalisms may represent the same constraints using different force concepts,
- changes of description can alter the apparent nature or number of forces without altering physical content.

This perspective explains familiar features of physical theory: the reformulation of interactions across different frameworks, the disappearance of forces under alternative parameterizations, and the variability of force concepts across theoretical contexts.

5.1 Forces as Field Invariants?

One might suggest that while forces themselves are not invariant, the associated fields are. This move does not resolve the difficulty. If fields are treated as invariant structures imposing constraints independently of representation, the same structural problems arise. Either the field duplicates locality-imposed constraints, or its invariance requires global fixity incompatible with locality. Recasting forces as fields therefore does not avoid the underlying tension.

6 Consequences

The primary consequence of the argument is that force realism must be abandoned. Forces cannot be treated as invariant features of reality without contradiction.

This conclusion does not rely on empirical data, dynamical assumptions, or particular physical models. It arises solely from structural considerations: the joint requirements of invariance and locality.

The present argument is not a restatement of instrumentalism. It does not claim that forces are merely useful fictions, nor does it appeal to pragmatic success. Rather, it shows that forces cannot occupy the structural role required of invariants without contradiction. The conclusion is reached by elimination, not reinterpretation.

7 Conclusion

We have shown that forces cannot be invariants. Treating them as such leads either to redundant constraint structures or to hidden global dependence incompatible with locality. The only coherent interpretation is that forces are representational artifacts of local description rather than invariant features of reality.

This result is eliminative, not constructive. It does not propose a replacement ontology of forces, but it narrows the space of coherent interpretations by ruling one out.