The Bearer of Scientific Acceptance: Objectivating Adequacy and the Limits of Constructive Empiricism

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Abstract

Constructive empiricism restricts the belief involved in scientific acceptance: to accept a theory is not to believe that it is true, but only that it is empirically adequate. This restriction is correct but incomplete. It restricts the doxastic force of acceptance while leaving its bearer too coarse, namely the whole theory. I argue that contemporary empiricism needs a second refinement: scientific acceptance should be allocated to objectivating content classes, understood as invariance classes of representational content that preserve a target-identifying, error-correcting, and projection-licensing role across admissible variations of formulation, model, measurement, mediation, and use. The corresponding criterion is objectivating adequacy. It is stronger than empirical adequacy because it requires public objectivation rather than mere saving of the observable phenomena; it is weaker than realism because it does not entail approximate truth, theoretical-kind realism, modal realism, or ontological grounding. The argument proceeds by diagnosing a selection gap in constructive empiricism, defining objectivating content classes, distinguishing objectivating adequacy from neighbouring notions, and testing the view on the Event Horizon Telescope image of M87*. The resulting position is a residual empiricism: a stance of content-level acceptance that accepts more precisely than constructive empiricism without converting stable scientific representation into selective realism by default.

Keywords: constructive empiricism; van Fraassen; scientific acceptance; empirical adequacy; scientific realism; scientific representation; measurement; objectivation; robustness; Event Horizon Telescope.

1 Introduction: the bearer problem

Constructive empiricism is normally presented as a restriction on belief. To accept a scientific theory is not to believe that the theory is true, but only that it is empirically adequate. Van Fraassen's canonical statement is that science aims to give us empirically adequate theories, where empirical adequacy is weaker than truth (van Fraassen, 1980, p. 12). This restriction does not make theoretical discourse instrumentalist. Van Fraassen's empiricism is literalist: theories are truth-evaluable; they are the kind of thing that can be true or false (van Fraassen, 1991, p. 3). The dispute with realism therefore does not concern whether theoretical claims have truth conditions. It concerns what scientific acceptance rationally requires us to believe.

This paper argues that the standard restriction is correct but incomplete. Constructive empiricism refines the *force* of acceptance, but not sufficiently its *bearer*. In the standard formulation, the theory remains the primary object accepted. One accepts a theory T, while believing only that T is empirically adequate. The doxastic attitude is weakened, but its object remains theory-level. That leaves open a more basic question: what, within a scientific theory and its associated practices, is actually accepted when the theory is used, trusted, corrected, projected, and retained without being believed true?

Call this the *bearer problem* for scientific acceptance. It is not the familiar question of whether acceptance entails belief in truth. It is the question of which unit receives the attitude of acceptance once the realist attitude toward whole theories has been rejected. Formally, constructive empiricism denies:

$$\mathrm{Accept}(T) \Rightarrow \mathrm{Believe}(\mathrm{True}(T)).$$

It maintains instead:

$$\mathrm{Accept}(T) \Rightarrow \mathrm{Believe}(\mathrm{EmpAdeq}(T)).$$

The present paper asks whether T should remain the relevant unit in the second formula. My answer is negative. In a scientifically adequate empiricism, the bearer of acceptance should not be the whole theory, nor the whole model, nor a bare observation sentence, nor an isolated datum, nor a theoretical entity. It should be an *objectivating content class*: an invariance class of representational content that preserves the same objectivating role across admissible variations of formulation, model, measurement, mediation, and use.

The positive thesis is:

$$\mathrm{Accept}_{RE}^{S,\Pi}([C]) \Rightarrow \mathrm{Believe}\big(\mathrm{ObjAdeq}_{S,\Pi}([C])\big),$$

where $[C]_{S,\Pi}$ is an objectivating content class relative to a scientific regime S and a local profile Π, and ObjAdeq is objectivating adequacy. This is the criterion by which a content is fit for scientific acceptance. It is stronger than empirical adequacy because it requires that a content publicly support the identification, stabilization, correction, and projective reuse of a phenomenon. It is weaker than realism because it does not entail that the content is true, approximately true, or ontologically grounded.

The pressure toward this view comes from inside constructive empiricism itself. Van Fraassen's semantic conception of theories already rejects a flat syntactic picture of theories. A theory is not primarily a set of sentences but a family of models; empirical adequacy is articulated through empirical substructures and their relation to phenomena (van Fraassen, 1989, pp. 226–227). Muller and van Fraassen emphasize that the slogan "truth about observable things" is only a rough formulation and that constructive empiricism is wedded to the semantic view (Muller and van Fraassen, 2008, pp. 197–198). If this is right, then the theory is already internally differentiated for the purpose of empirical adequacy. Acceptance therefore needs an analogous internal differentiation.

The pressure is reinforced by van Fraassen's later account of scientific representation. In *Scientific Representation*, representation is not exhausted by theories or theoretical models. It proceeds through concrete and abstract artifacts, such as graphs, scale models, diagrams, computer displays, mathematical models, instruments, and measurement outcomes (van Fraassen, 2008, pp. 1–3). Measurement is itself a form of representation: it locates a target in a theoretically articulated logical space rather than simply mirroring a pre-given reality. Once representation is distributed across models, instruments, measurement procedures, data practices, perspectives, and uses, it is no longer plausible that a whole theory is the precise bearer of acceptance.

The same point arises from the observability debate. Ladyman argues that constructive empiricism cannot treat observability as objective without facing questions about modal structure (Ladyman, 2000, 2004). Muller replies that observability is a scientifically determinable ability, even if vague and anthropocentric (Muller, 2005). Contessa adds that scientific theory acceptance often concerns theoretical kinds, not merely observable individuals; observing an individual does not settle whether it instantiates a theory-laden kind (Contessa, 2006). Ladyman's more recent scientific empiricism pushes empiricism away from human sense-experience and toward data, information channels, and modal structure (Ladyman, 2025). These debates show that the observable/unobservable distinction, even if coherent, cannot by itself select the content that is accepted in scientific practice.

The paper develops this diagnosis into a positive position. Section 2 identifies the selection gap in constructive empiricism. Section 3 defines objectivating content classes and admissible variation. Section 4 defines objectivating adequacy and distinguishes it from empirical adequacy, instrumental success, robustness, model adequacy, approximate truth, and ontological commitment. Section 5 uses the Event Horizon Telescope image of M87* as the central scientific case. Section 6 answers the realist-collapse objection by isolating the additional grounding premise required by selective realism, theoretical-kind realism, and modal realism. Section 7 formulates residual empiricism as a stance of content-level acceptance.

The view is residual in a precise sense. It does not replace empirical adequacy with realism. It extracts, from the scientific use of theories and models, the residual content that is fit to be accepted without being treated as ontologically disclosed. Residual empiricism therefore says neither that we should believe less, nor that we should believe the stable parts of science to be real. It says that we should accept more precisely.

2 The selection gap in constructive empiricism

2.1 Literalism is not enough

Constructive empiricism begins from a distinction between meaning and belief. Theoretical claims are not reduced to observational shorthand. Claims about electrons, fields, spacetime curvature, black holes, quantum states, or forces are meaningful and truth-evaluable. Van Fraassen's empiricist restriction is not semantic deflation but doxastic restraint. Scientific acceptance does not require belief that the theory is true; it requires, at most, belief that the theory is empirically adequate (van Fraassen, 1980, 1991).

This distinction avoids instrumentalism, but it does not determine the bearer of acceptance. If theories are taken literally, then they contain many truth-evaluable claims. Some concern target phenomena; others concern idealized models, limiting constructions, auxiliary assumptions, measurement procedures, mathematical devices, boundary conditions, and possible interpretations. Literalism tells us that these claims have content. It does not tell us which of them should receive acceptance.

The issue is structural. A theory is not a homogeneous block. It contains laws, model classes, idealizations, auxiliary assumptions, parameters, measurement procedures, data-model relations, representational conventions, mathematical surplus structure, domain restrictions, and metaphysical interpretations. These elements do not have the same function. Some are essential to the public stabilization of a phenomenon; some are calculational scaffolding; some are dispensable idealizations; some are metaphysical interpretations; some are local approximations; some are artifacts of a representational system. A single attitude directed at the whole theory is therefore too coarse.

Realists have long recognized an analogous allocation problem. The pessimistic induction undermines global realism about whole theories (Laudan, 1981). Structural realism relocates continuity from entities to structure, but then must say which structures receive realist commitment (Worrall, 1989). Selective realism and semi-realism identify the components responsible for success and retention through change (Psillos, 1999; Chakravartty, 2007). Residual empiricism accepts the same allocation problem but changes its target. Before asking which components deserve realist commitment, we must ask which components deserve scientific acceptance.

2.2 The semantic view intensifies the problem

Van Fraassen's semantic conception of theories strengthens rather than weakens the bearer problem. On the syntactic conception, one might try to isolate empirical content by distinguishing observational from theoretical vocabulary. Van Fraassen rejects that route. In the semantic view, a theory is given by a class of models, and its empirical adequacy is characterized by the relation between empirical substructures and phenomena (van Fraassen, 1989, pp. 226–227). Muller and van Fraassen later stress that the informal formulation of empirical adequacy as truth about observable things is only a rough way of speaking; the official account belongs to the semantic view (Muller and van Fraassen, 2008, pp. 197–198).

This move creates an internal selection problem. A model does not represent a domain by every feature it possesses. Coordinates, gauges, idealizations, boundary conditions, auxiliary constructions, and mathematical artifacts may be indispensable to the model without being the accepted scientific content. Nor do empirical substructures by themselves settle the matter. They help articulate empirical adequacy, but they do not yet identify the content that scientists accept, reuse, correct, and retain across changes of formulation and mediation.

The selection gap can be stated as follows:

$$\mathrm{EmpAdeq}(T) \nRightarrow \mathrm{SelAcc}(T).$$

Empirical adequacy is a criterion for accepting a theory. It does not, by itself, specify which content within the theory and its associated practices carries acceptance. A theory may be empirically adequate while several of its internal components are merely auxiliary. Conversely, a content may be acceptance-worthy within a restricted regime even when the larger theory in which it appears contains idealizations or metaphysical interpretations that are not accepted.

The relevant contrast is therefore:

empirical adequacy:	Can the theory save the observable phenomena?
objectivating adequacy:	Which content stabilizes a phenomenon for public scientific use?

The first question remains van Fraassenian. The second question is residual. It asks what, after the rejection of theory-level belief in truth, remains as the proper bearer of acceptance.

2.3 Representation and measurement distribute the bearer

Van Fraassen's later work on representation makes the selection gap unavoidable. Scientific representation is not a two-place relation between a theory and the world. It involves artifacts, users, perspectives, measurement setups, and practical constraints (van Fraassen, 2008). Hughes's DDI account similarly treats modeling as involving denotation, demonstration, and interpretation rather than a single mirror-like relation between model and target (Hughes, 1997). Giere shifts the focus from semantic relations alone to the pragmatic activity by which agents use models to represent aspects of the world for specific purposes (Giere, 2004). Suarez rejects similarity and isomorphism as sufficient accounts of representation and emphasizes inferential use (Suárez, 2003). Frigg and Nguyen likewise frame scientific representation as an activity involving models, keys, targets, and users (Frigg and Nguyen, 2020).

Measurement supplies the most direct reason to move below the theory level. Van Fraassen distinguishes phenomena from appearances: phenomena are observable entities, events, and processes; appearances are the contents of observation or measurement outcomes (van Fraassen, 2008, pp. 7–9, 283–285). A measurement outcome is not simply the phenomenon itself. It is the way a phenomenon appears in a measurement setup and within a representational space. Tal's model-based account of measurement standardization makes a related point: standard measurement involves coordinating quantity concepts, models, instruments, exemplary artifacts, and procedures of application (Tal, 2016). Scientific acceptance is therefore not directed at naked data or at whole theories. It is directed at contents stabilized through representational and measurement practices.

Bogen and Woodward's distinction between data and phenomena gives the same lesson in another idiom (Bogen and Woodward, 1988). Data are local, noisy, device-dependent products of particular experimental arrangements. Phenomena are stable patterns or processes inferred from data and used as targets of explanation. The accepted item is not the raw datum, and it need not be the whole theory that explains the phenomenon. It is the content that bridges data and phenomenon by stabilizing a public target of inquiry.

Peschard's criticism of model-target dyadism is relevant here. Models should not be understood only by their relation to a target; they operate inside an epistemic space of related models-of-phenomena and activities of modeling (Peschard, 2011). This is precisely why the bearer of acceptance should be an invariance class of content rather than a single model. A content may survive across several models, data reductions, measurement procedures, and uses. That surviving content is often what scientists treat as available for further inquiry.

2.4 Observability, kinds, and modality do not solve selection

The observable/unobservable distinction does not solve the bearer problem. Even if observability is a coherent and usable distinction, it determines a boundary of epistemic access, not a unit of acceptance. To know that an individual is observable, or that a measurement outcome has occurred, is not yet to know which content stabilizes the relevant phenomenon under changes of model, mediation, correction, and projection.

The debate between Ladyman, Monton and van Fraassen, and Muller shows why the issue is deeper than vagueness. Ladyman argues that observability involves modal commitments because claims about what is observable often concern what would be observed under appropriate conditions (Ladyman, 2000, 2004). Monton and van Fraassen reply that constructive empiricism can remain compatible with modal nominalism (Monton and van Fraassen, 2003). Muller offers a rescue by treating observability as our scientifically determinable ability to observe (Muller, 2005). Residual empiricism need not deny that this rescue is viable. It denies that the rescued notion of observability can select the bearer of acceptance.

Contessa's theoretical-kind objection makes this point sharper. Scientific commitment often concerns kinds, not isolated observable individuals (Contessa, 2006). Observing a person does not amount to observing that she is a witch in the sense required by demonological theory; observing a track, spectrum, droplet, spot, or display does not by itself amount to observing the theoretical kind under which a theory classifies it. Residual empiricism generalizes the lesson. One may accept the content that supports stable classification under a kind term without accepting the kind as an ontological posit.

Ladyman's scientific empiricism creates a stronger pressure. He argues that empiricism should no longer privilege the contents of unaided sense experience. Scientific empiricism should privilege observational and experimental data; but data are produced through information channels and seem to presuppose modal structure (Ladyman, 2025). Residual empiricism accepts the first correction and resists the second inference. Data, instruments, and information channels are indispensable to modern empiricism. But they are not the final bearer of acceptance. They contribute to objectivating content classes. The modal discipline required for their use does not automatically entail modal realism.

The upshot is that neither whole theories, nor empirical substructures alone, nor observable entities, nor raw data, nor theoretical kinds are sufficiently precise bearers of acceptance. What is needed is a content-level unit selected by its public objectivating role.

3 Objectivating content classes

3.1 Regimes, profiles, and admissible variation

The notion of an objectivating content class must be defined without turning it into a private vocabulary. It is best understood as an invariance class of representational content. The relevant invariance is not purely formal; it is functional and practice-indexed. A content belongs to the same class when it preserves the same target-identifying, error-correcting, and projection-licensing role across admissible transformations.

Definition 3.1 (Scientific regime)**.** A scientific regime S is a locally organized practice comprising: a target domain; representational resources; measurement and calibration procedures; standards of error, correction, and uncertainty; accepted forms of modeling; and inferential uses authorized within that practice.

A regime is not a theory. It includes theories, models, instruments, data practices, standards, and uses. For example, horizon-scale VLBI imaging of compact radio sources is a regime; so is classical elasticity under small-deformation assumptions; so is spectroscopic classification under specified calibration standards.

Definition 3.2 (Local profile)**.** A local profile Π specifies the target phenomenon, domain restrictions, scale, background conditions, measurement space, relevant contrasts, admissible idealizations, standards of correction, uncertainty profile, and defeater conditions under which a content is assessed.

Indexing to S and Π is essential. No content is objectivatingly adequate in the abstract. Adequacy is local: it is adequacy for stabilizing a phenomenon under a regime and profile. The same formula, image, model, or parameter may play different roles across regimes. Conversely, different formulations may express the same objectivating content within a single profile.

Definition 3.3 (Admissible variation)**.** A variation v of formulation, model, measurement procedure, data reduction, instrument calibration, representation, or use is admissible relative to S, Π iff it preserves the target contrast, measurement or representational space, correction procedures, uncertainty profile, and defeater conditions fixed by S, Π, while varying only elements not fixed as constitutive for that local objectivating role.

This definition blocks arbitrariness. Not every transformation is admissible. A change that alters the target phenomenon, changes the scale, removes the relevant error model, or suppresses defeaters does not count as a harmless variation. Admissibility is fixed by the practice, not by the philosopher's convenience.

3.2 From content tokens to content classes

A content token may be presented by a sentence, equation, graph, image, parameter estimate, model structure, diagram, measurement outcome, or simulation output. But none of these vehicles is automatically the accepted content. A formula may be a presentation of content. A model may host content. An image may display content. A measurement may produce content. Yet the accepted unit is the content that remains stable through the relevant vehicles and practices.

Definition 3.4 (Objectivating equivalence)**.** Let C_i and C_j be candidate representational contents within S, Π. Then

$$C_i \sim^{\text{obj}}_{S,\Pi} C_j$$

iff substituting C_i for C_j in the admissible practices of S under Π preserves: (i) individuation of the same target phenomenon; (ii) the relevant calibration and correction procedures; (iii) the defeater profile; (iv) the projections licensed by the content; and (v) the distinction between content, representational scaffold, noise, and artifact. The objectivating content class generated by C is:

$$[C]_{S,\Pi} = \{C_i : C_i \sim^{\text{obj}}_{S,\Pi} C\}.$$

The class is an equivalence class only relative to a regime and profile. It is not a metaphysical natural kind. It is a way of tracking which contents perform the same objectivating function across admissible variations. This gives the notion a clear non-idiosyncratic interpretation: an objectivating content class is an invariance class of representational content.

This also distinguishes the class from neighbouring units. It is not a whole theory, because a theory contains more than the content that objectivates a phenomenon. It is not a whole model, because models contain scaffolding, idealizations, and artifacts. It is not a datum, because data are local products of particular measurement arrangements. It is not an observable individual, because observability does not fix the content that stabilizes the phenomenon. It is not a theoretical kind as an ontological posit, because classification can be accepted without kind realism. It is not an instrument, because instruments produce appearances and data rather than themselves being the accepted content.

The resulting structure is:

$$\text{vehicle} \neq \text{objectivating content} \neq \text{ontological ground.}$$

The vehicle may be an image, model, formula, or dataset. The objectivating content is what survives across admissible vehicles and supports public scientific use. The ontological ground, if any, is a further realist posit.

3.3 Why the class is not merely pragmatic

One might object that this account reduces acceptance to use. That would be too weak. The class is use-indexed, but not merely useful. A content must be stable under correction and exposed to defeat. Its role is public, not private; constrained, not arbitrary; revisable, not immune. The aim is not to identify whatever scientists happen to use, but to specify the conditions under which a content is fit to bear acceptance.

Thus the class is not fixed by psychological salience or current convenience. It is fixed by invariance under admissible variation. If a content can be used only by suppressing relevant error sources, only under a single data reduction, only through a fragile representational convention, or only by ignoring known defeaters, it does not qualify as an objectivating content class. It may be heuristically useful. It is not yet fit for residual acceptance.

This is why objectivating content classes are more demanding than pragmatic adequacy-for-purpose. A model may be adequate for a local purpose, such as rough interpolation, visualization, or engineering prediction, while failing to stabilize any public phenomenon. A content class becomes acceptance-worthy only when it supports identification, correction, and projection in ways that can be checked and withdrawn.

4 Objectivating adequacy

4.1 The criterion

Objectivating adequacy is the criterion corresponding to objectivating content classes. It states when a content class is fit to be accepted.

Definition 4.1 (Objectivating adequacy)**.** A content class $[C]_{S,\Pi}$ is objectivatingly adequate iff it publicly supports, within S and Π, the identification, stabilization, correction, projective reuse, and defeasible control of a target phenomenon:

$$\mathrm{ObjAdeq}_{S,\Pi}([C]) \iff \mathrm{Id}_{S,\Pi}([C]) \wedge \mathrm{Sta}_{S,\Pi}([C]) \wedge \mathrm{Corr}_{S,\Pi}([C]) \wedge \mathrm{Proj}_{S,\Pi}([C]) \wedge \mathrm{Def}_{S,\Pi}([C]).$$

The five clauses are as follows. Id requires that the content help determine what counts as the same target phenomenon rather than a merely similar occurrence. Sta requires stability across admissible changes of formulation, model, measurement, mediation, or use. Corr requires participation in error control, calibration, and discrimination between signal, noise, artifact, and admissible variation. Proj requires licensed reuse beyond the immediate case of production. Def requires exposure to specified defeaters: conditions under which acceptance would be withdrawn, restricted, or revised.

The fifth clause is important. A content that cannot fail is not objectivatingly adequate; it is insulated. Objectivating adequacy is not mere resilience. It is disciplined resilience under acknowledged standards of correction and defeat. This makes the criterion more demanding than robustness alone and prevents an accepted content from becoming dogmatic.

4.2 Distinctions from neighbouring notions

Objectivating adequacy must be distinguished from several nearby notions.

First, it is not empirical adequacy. Empirical adequacy asks whether a theory saves the observable phenomena, or, in semantic terms, whether relevant empirical structures can be embedded in models allowed by the theory (van Fraassen, 1989). Objectivating adequacy asks which content, across models and mediations, is responsible for making a phenomenon publicly identifiable, corrigible, and reusable. Thus:

$$\mathrm{EmpAdeq}(T) \nRightarrow \mathrm{ObjAdeq}_{S,\Pi}([C]).$$

A theory can be empirically adequate without every content it contains being objectivatingly adequate. Conversely, a content can be objectivatingly adequate within a local profile even if the broader theory contains unaccepted idealizations or metaphysical interpretations.

Second, objectivating adequacy is not instrumental success. Instrumental success is task-relative reliability without commitment to a stable public target. A black-box system may predict detector outputs accurately while providing no content that fixes what counts as the same phenomenon, what counts as error, or what can be projected to new contexts. Instrumental success is therefore weaker:

$$\mathrm{InstrSucc}_{S,\Pi}([C]) \nRightarrow \mathrm{ObjAdeq}_{S,\Pi}([C]).$$

Objectivating adequacy requires public content, not merely successful performance.

Third, objectivating adequacy is not robustness. Robustness, in Wimsatt's sense, concerns stability of results across independent derivations, models, or procedures (Wimsatt, 2007). Robustness is often evidentially important, but it is not sufficient. A robust artifact remains an artifact. A result may survive variations because several procedures share the same hidden bias, background assumption, or calibration error. Hence:

$$\mathrm{Robust}_{S,\Pi}([C]) \nRightarrow \mathrm{ObjAdeq}_{S,\Pi}([C]).$$

Robustness contributes to Sta, and sometimes to Corr, but objectivating adequacy additionally requires target individuation, anti-artifact control, projection, and defeasible exposure.

Fourth, objectivating adequacy is not model adequacy. A model may be adequate for a particular purpose relative to a target, a context, and a set of tolerances. Objectivating adequacy concerns whether a content class remains invariant and scientifically usable across a family of models, measurements, and representational artifacts. Thus:

$$\mathrm{ModelAdeq}_{S,\Pi}(M) \nRightarrow \mathrm{ObjAdeq}_{S,\Pi}([C]).$$

A model can be locally adequate while the content it presents is not stable across admissible transformations. Conversely, the same objectivating content may be presented by multiple models none of which is privileged as the bearer of acceptance.

Fifth, objectivating adequacy is not truth, approximate truth, or truthlikeness. The accepted content may be truth-evaluable; residual empiricism is not instrumentalism. But acceptance requires belief in objectivating adequacy, not belief in truth:

$$\mathrm{ObjAdeq}_{S,\Pi}([C]) \nRightarrow \mathrm{ApproxTrue}([C]).$$

Truth may be a realist interpretation of why the content succeeds. It is not built into the criterion of acceptance.

Sixth, objectivating adequacy is not ontological commitment. Ontological commitment requires commitment to the existence or worldly grounding of the entities, structures, kinds, dispositions, or modal relations represented by the content. Objectivating adequacy requires only that the content function as a stable public unit of identification, correction, and projection. Formally:

$$\mathrm{ObjAdeq}_{S,\Pi}([C]) \nRightarrow \mathrm{Believe}\big(\exists G\ \mathrm{Ground}(G, [C])\big).$$

This non-implication is the central anti-collapse condition of residual empiricism.

4.3 A negative test: prediction without objectivation

A criterion earns its keep by excluding cases. Consider a black-box predictor trained on previous detector outputs, calibration metadata, and environmental variables. Suppose it predicts future readings with high reliability in a stable laboratory setting. It may therefore satisfy a strong instrumental standard. Yet it fails objectivating adequacy if its internal variables do not identify a target phenomenon, if no correction procedure distinguishes signal from artifact, if its success collapses under changed instruments, and if it lacks a defeater profile beyond distributional failure.

The case is schematic, but the point is general. Predictive reliability alone does not identify the content accepted by science. A device may be reliable without yielding a content that can be publicly stabilized, corrected, and transported. Residual empiricism therefore differs from both instrumentalism and mere data empiricism. It requires more than predictive success but less than ontological disclosure.

4.4 Defeaters and withdrawal of acceptance

Objectivating adequacy is defeasible. Acceptance must be withdrawn, restricted, or revised when the conditions fixing the content class fail. Four defeater types are especially important.

First, *target defeaters*: further inquiry shows that the alleged content does not identify the same phenomenon across admissible contexts. Secondly, *artifact defeaters*: the stable pattern is generated by shared instrument bias, data processing, background priors, or representational conventions. Thirdly, *projection defeaters*: the content cannot be transported to contexts that it was used to license. Fourthly, *profile defeaters*: the local profile Π was misdescribed, so the apparent adequacy holds only under narrower or different conditions.

These defeaters make residual acceptance neither dogmatic nor merely sociological. The accepted content is stable only under specified regimes and profiles. It remains open to defeat by further measurement, calibration, modeling, and comparison.

5 Case study: the Event Horizon Telescope and M87*

5.1 Why EHT is the right test case

Hooke's law can illustrate the distinction between formula, content, and ontological ground, but it does not sufficiently test it. The Event Horizon Telescope image of M87* does. It involves instrumentally mediated observation, sparse data, data reconstruction, multiple imaging pipelines, statistical modeling, simulation, theoretical interpretation, public imagery, robustness reasoning, and immediate realist pressure. It therefore forces the distinction between the image as artifact, the data as local products, the pipelines as mediating procedures, the theory as background, and the content that is actually acceptance-worthy.

The EHT Collaboration's first image of M87* was produced from 2017 observations by a global VLBI array at 1.3 mm wavelength. The first results describe an event-horizon-scale image of the supermassive black-hole candidate at the center of M87 (Akiyama et al., 2019a). The imaging paper reports a prominent ring with diameter approximately 40 μas, persistent across four observing nights, with enhanced brightness in the south (Akiyama et al., 2019d). The shadow-and-mass paper develops crescent models and argues that such models are statistically preferred over other comparably complex geometric models considered (Akiyama et al., 2019f). Doboszewski and Elder argue that the justificatory structure of the EHT image is a robustness argument: the reliable features are those stable across variations in data-analysis pipelines, while features such as azimuthal profile, thickness, and some brightness details are less secure (Doboszewski and Elder, 2024).

This is a natural application of residual empiricism. The accepted item is not the whole general theory of relativity, not the full GRMHD simulation space, not the total EHT image, not a raw dataset, not a data-analysis pipeline, and not the metaphysical claim that the world contains exactly the represented structure. The accepted item is a selected content class.

5.2 The EHT content class

Let S_{EHT} be the scientific regime of horizon-scale VLBI imaging of compact radio sources, including instrument synchronization, calibration, visibility data, closure quantities, imaging algorithms, synthetic-data tests, model fitting, and standards of uncertainty. Let Π_{M87^*} be the local profile concerning the 2017 EHT observations of the compact radio source at the center of M87, with the relevant angular scale, frequency band, calibration standards, imaging constraints, and astrophysical background assumptions.

Let $\mathcal{R}_{M87^*}$ denote a compact, asymmetric, ring-like emission structure with a central brightness depression and a stable diameter of approximately 40 μas. The relevant content class is:

$$[C]_{EHT,M87^*} = [\mathcal{R}_{M87^*}]_{S_{EHT},\Pi_{M87^*}}.$$

This formula is deliberately not a statement that "the image is true," nor that "general relativity is true," nor that "the Kerr metric is confirmed," nor that "the photon ring has been directly observed." It states the content that is stabilized by the EHT process under admissible variation.

The admissible variations include differences among imaging pipelines, regularization choices, blind imaging teams, geometric model families, observing nights, and calibration procedures, insofar as they preserve the target profile and the relevant standards of reconstruction and error control. They do not include arbitrary changes that remove the target, alter the angular scale, ignore calibration standards, or suppress known uncertainty sources.

5.3 Objectivating adequacy in the EHT case

The EHT content satisfies the five clauses of objectivating adequacy in a restricted and defeasible way.

First, it satisfies Id. The content identifies a public target: not merely a display image, but a compact horizon-scale radio-emission structure associated with M87*. It fixes what counts, within the regime, as the target phenomenon rather than merely a local feature of one reconstruction.

Second, it satisfies Sta. The ring-like structure and diameter are stable across admissible imaging methods and observing nights. Doboszewski and Elder's analysis is especially important here:

not all image features are equally robust. The ring persists; some more detailed features do not (Doboszewski and Elder, 2024). Residual empiricism treats this asymmetry as philosophically decisive. The accepted content is not the whole image. It is the robust content selected from the image-producing process.

Third, it satisfies Corr. The EHT process includes calibration, error control, synthetic-data testing, independent teams, and comparisons among pipelines. These procedures are not external add-ons. They are part of what makes the content objectivating. They allow scientists to distinguish a stable target-related feature from noise, artifact, or confirmation bias.

Fourth, it satisfies Proj. The content can be reused in further scientific contexts: comparison with geometric crescent models, constraints on the mass scale, tests of consistency with black-hole spacetimes, comparison with simulations, and later EHT observations including polarization studies. Projection here does not mean unlimited extrapolation. It means licensed reuse under specified conditions.

Fifth, it satisfies Def. The content is defeasible. Acceptance would be weakened or withdrawn if the ring were shown to be an artifact of shared pipeline assumptions, if calibration errors generated the stable feature, if synthetic-data tests failed to discriminate alternative sources, or if later observations under comparable conditions systematically undermined the ring-like structure. This defeater profile matters because it prevents the EHT case from becoming a triumphalist realist anecdote.

5.4 What is not accepted

The EHT case also clarifies what residual empiricism refuses to accept by default. It does not accept the entire visual image as a faithful likeness of M87*. It does not accept every feature of the brightness distribution. It does not accept every element of the GRMHD simulations used to interpret the image. It does not accept a full metaphysics of event horizons, photon rings, accretion physics, or spacetime structure. It does not even require belief that the best explanation of the robust content is a corresponding ontological structure.

This does not make the case weak. On the contrary, it shows why objectivating adequacy is the right middle level. The EHT result is much stronger than an instrumental success. It is not merely a predictor of observations. It stabilizes a public phenomenon through a complex representational and measurement process. But it is also weaker than full realism. The realist may add that the best explanation of this robust objectivation is the real structure of a black hole spacetime. Residual empiricism treats that as an additional inference, not as part of acceptance itself.

The EHT case therefore supports the central ordering:

$$\text{instrumental success} < \text{objectivating adequacy} < \text{ontological commitment}.$$

The left-hand inequality matters because EHT gives more than successful prediction or visual output. The right-hand inequality matters because not every robustly objectivated feature is thereby ontologically grounded.

6 Against realist collapse

6.1 The collapse objection

The strongest objection is that residual empiricism is unstable. If a content is stable across admissible variations, correctable, projectively reusable, and indispensable to the public objectivation of a phenomenon, then it seems to be exactly the sort of content realists should believe. The position may therefore appear to collapse into selective realism.

Objection 6.1 (Realist collapse)**.** If $[C]$ is stable, corrigible, projectively reusable, and indispensable to objectivation, then $[C]$ is already more than empirically acceptable. Its success is best explained by the fact that it tracks, corresponds to, or is grounded in a real worldly structure. Residual empiricism is therefore selective realism without the name.

The objection is serious. Residual empiricism is stronger than constructive empiricism as usually formulated. It does not stop at a whole theory's empirical adequacy. It identifies acceptance-worthy contents within scientific practice. But the inference to realism still requires an additional premise.

Principle 6.1 (Separation of objectivating authority and ontological grounding)**.**

$$\mathrm{ObjAdeq}_{S,\Pi}([C]) \Rightarrow \mathrm{Authority}^{acc}_{S,\Pi}([C]),$$

but

$$\mathrm{Authority}^{acc}_{S,\Pi}([C]) \not\Rightarrow \mathrm{Believe}\big(\exists G\ \mathrm{Ground}(G,[C])\big).$$

Objectivating adequacy confers authority to accept, use, correct, project, and retain a content within scientific inquiry. It does not by itself confer authority to treat that content as ontologically grounded.

The realist adds a further explanatory premise:

$$\mathrm{ObjAdeq}_{S,\Pi}([C]) \wedge \mathrm{IBE}\big(\mathrm{Ground}([C]), \mathrm{ObjAdeq}([C])\big) \Rightarrow \mathrm{Real}([C]).$$

Residual empiricism does not refute this premise in every case. It denies that it is included in scientific acceptance as such. The disagreement is not over whether stable content may be selected. It is over how that selection is to be interpreted. Selective realism treats stability, indispensability, and projective success as defeasible evidence for worldly structure. Residual empiricism treats them as defeasible evidence for acceptance-worthiness unless a distinct grounding argument is supplied.

6.2 Theoretical kinds

The same anti-collapse structure applies to theoretical kinds. Contessa is right that observability is not a sufficient guide to cautious ontological commitment because scientific theories often classify individuals under theory-laden kinds (Contessa, 2006). Residual empiricism accepts the diagnosis but not the realist conclusion.

A content may support classification under a kind K without settling the ontology of K:

$$\mathrm{Classifies}_{S,\Pi}([C], K) \nRightarrow \mathrm{Real}_{S,\Pi}(K).$$

In the EHT case, the content supports classification of the target as a compact horizon-scale black-hole candidate under a rich astrophysical framework. But stable classification is not identical with ontological commitment to every theoretical kind or structure invoked in that framework. The realist may argue that the best explanation of stable classification is the reality of the corresponding kind. Residual empiricism again treats that as an additional inference.

6.3 Modal discipline without modal realism

Ladyman's objection is more fundamental. If data and information channels require modal structure, and if residual empiricism accepts contents stabilized through such channels, then it may seem committed to modal realism (Ladyman, 2025). The reply is to distinguish modal discipline from modal metaphysics.

Objectivating adequacy requires counterfactual and projective discipline. A content must remain stable under admissible variations. It must support corrections, identify artifacts, and license projections. These are modal features of scientific use. But it does not follow that the accepted content is believed to be grounded in objective modal structure. Formally:

$$\mathrm{ObjAdeq}_{S,\Pi}([C]) \Rightarrow \mathrm{ModDisc}_{S,\Pi}([C]),$$

but

$$\mathrm{ModDisc}_{S,\Pi}([C]) \nRightarrow \mathrm{ModReal}_{S,\Pi}([C]).$$

Residual empiricism does not deny that science uses modal discipline. It denies that the discipline of use entails a metaphysics of modality. The realist is free to argue that reliable objectivation is best explained by modal structure in the world. The residual empiricist denies that this is already part of acceptance.

6.4 Perspectival realism and the stronger realist alternative

A more sophisticated realist may avoid crude correspondence realism and appeal to perspectival realism. Massimi argues that scientific knowledge is situated in historically and materially embedded epistemic perspectives while remaining realist in a qualified sense (Massimi, 2022). This is closer to residual empiricism than traditional theory realism, because it takes practice, perspective, and model plurality seriously.

The difference is nevertheless exact. Perspectival realism interprets situated, practice-bound knowledge as realist under appropriate conditions. Residual empiricism does not. It treats situated objectivation as sufficient for scientific acceptance but insufficient for ontological commitment. The two views can agree that scientific knowledge is mediated, perspectival, model-based, and plural. They disagree over whether stabilized perspectival success licenses realism.

This contrast is important because residual empiricism should not be read as a weak version of perspectival realism. It is a stance of restraint concerning the transition from objectivation to ontology. It grants that scientific contents can be stable, public, corrected, and projective. It refuses to identify those features with worldly grounding unless a further argument is supplied.

7 Residual empiricism as a stance of content-level acceptance

7.1 The doxastic component

Residual empiricism preserves the van Fraassenian insight that acceptance is not belief in the truth of the accepted theory. It changes the bearer and the criterion. The accepted item is not T, the whole theory, but $[C]_{S,\Pi}$, an objectivating content class. The belief required is not belief in truth or approximate truth, but belief in objectivating adequacy:

$$\mathrm{Accept}_{RE}^{S,\Pi}([C]) \Rightarrow \mathrm{Believe}\big(\mathrm{ObjAdeq}_{S,\Pi}([C])\big).$$

This doxastic commitment is stronger than mere instrumental reliance. The subject believes that the content is publicly adequate for objectivation. But it remains weaker than realism:

$$\mathrm{Accept}_{RE}^{S,\Pi}([C]) \not\Rightarrow \mathrm{Believe}\big(\mathrm{Real}([C])\big),$$

and

$$\mathrm{Accept}_{RE}^{S,\Pi}([C]) \not\Rightarrow \mathrm{Believe}\big(\exists G\ \mathrm{Ground}(G,[C])\big).$$

The position is therefore not skepticism about scientific content. It is a selective discipline of acceptance without automatic ontological extension.

7.2 The pragmatic component

Acceptance also has a pragmatic component. To accept a theory, for van Fraassen, is not merely to believe a proposition; it involves using the theory, adopting it as a guide to research, and relying on it in scientific practice (van Fraassen, 2008). Residual empiricism relocates this pragmatic component. The practical commitments of acceptance attach primarily to content classes rather than whole theories.

To accept $[C]_{S,\Pi}$ is to use it as a stable unit for measurement, classification, correction, modeling, and projection under the relevant regime. It is to treat it as a public object of inquiry, open to further refinement and defeat. It is not to accept every vehicle by which $[C]$ is represented, nor every theory in which it is embedded, nor every metaphysical interpretation attached to it.

This makes residual empiricism a stance in van Fraassen's sense (van Fraassen, 2002). It is not a thesis that the world contains only objectivating contents. It is not a denial that theoretical entities or structures exist. It is a policy governing the transition from scientific practice to commitment. Accept what is objectivatingly adequate; suspend the further inference to ontology unless a distinct realist argument establishes it.

7.3 Comparative location

The position can be located by comparing the relevant unit, criterion, and commitment.

View	Primary unit	Criterion	Commitment
Instrumentalism	Instrument or predictive device	Successful use	No literal commitment to theoretical content
Constructive empiricism	Theory T	Empirical adequacy	Belief that T is empirically adequate, not true
Model adequacy approaches	Model M for a purpose	Adequacy relative to target and purpose	Local model use, often without theory-level belief
Selective realism	Selected entity, property, or structure	Success, retention, indispensability, explanation	Realist commitment to selected worldly structure
Residual empiricism	Objectivating content class $[C]_{S,\Pi}$	Objectivating adequacy	Acceptance of public objectivating content without default ontological grounding

Residual empiricism is not merely a midpoint by compromise. It occupies a distinct logical space. It agrees with constructive empiricism that acceptance does not require belief in truth. It agrees with model-based representation that scientific content is mediated and use-dependent. It agrees with robustness approaches that stability across variation is evidentially significant. It agrees with selective realism that epistemic selection is necessary. It denies that any of these points by itself yields ontological commitment.

7.4 Conclusion

Constructive empiricism was right to separate acceptance from belief in truth. But once theories are understood semantically, once measurement and representation are recognized as mediating practices, once data and phenomena are distinguished, and once observability is shown not to select accepted scientific content, theory-level acceptance becomes too coarse. The empiricist should refine not only the force of acceptance but its bearer.

The proper bearer is the objectivating content class: an invariance class of representational content that preserves a target-identifying, error-correcting, and projection-licensing role under admissible variation. The proper criterion is objectivating adequacy: public support for identification, stabilization, correction, projection, and defeasible control. The EHT case shows why this refinement matters. What is acceptance-worthy in the first image of M87* is not the whole image, the whole theory, or the full ontology of black-hole spacetime, but a robust content class: a compact, asymmetric, ring-like structure with a central brightness depression and stable approximate diameter under admissible imaging variation.

The resulting empiricism is stronger than standard empirical adequacy because it identifies the contents that science actually stabilizes and reuses. It is weaker than realism because it refuses to infer from objectivation alone to ontological grounding. Residual empiricism therefore gives a content-level answer to the bearer problem: accept what has been publicly objectivated, but do not treat objectivation itself as a disclosure of ontology.

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