

### Noether's Theorem and the Physics of Symmetry

Noether, Emmy. "Invariante Variationsprobleme." *Nachrichten von der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-Physikalische Klasse* (1918): 235–257. The original paper. Available in English translation by M. A. Tavel in *Transport Theory and Statistical Physics* 1, no. 3 (1971): 186–207.

Kosmann-Schwarzbach, Yvette. *The Noether Theorems: Invariance and Conservation Laws in the Twentieth Century*. Translated by Bertram E. Schwarzbach. New York: Springer, 2011. The standard scholarly history. Treats both theorems with full mathematical detail and reconstructs the Göttingen context, including the Hilbert-Klein-Einstein correspondence that occasioned the work.

Neuenschwander, Dwight E. *Emmy Noether's Wonderful Theorem*. Revised edition. Baltimore: Johns Hopkins University Press, 2017. A physicist's exposition pitched at advanced undergraduates. Useful for the Lagrangian formalism and the derivation of specific conservation laws from specific symmetries.

Byers, Nina. "E. Noether's Discovery of the Deep Connection Between Symmetries and Conservation Laws." *Israel Mathematical Conference Proceedings* 12 (1999). Concise intellectual history situating Noether's results within the energy-conservation crisis in general relativity.

Brading, Katherine. "Which Symmetry? Noether, Weyl, and Conservation of Electric Charge." *Studies in History and Philosophy of Modern Physics* 33, no. 1 (2002): 3–22. Philosophically careful treatment of the relationship between Noether's first and second theorems, global and gauge symmetries, and the conservation of charge.

### Symmetry Breaking

Goldstone, Jeffrey. "Field Theories with 'Superconductor' Solutions." *Il Nuovo Cimento* 19, no. 1 (1961): 154–164. The original statement of Goldstone's theorem.

Nambu, Yoichiro. "Quasi-Particles and Gauge Invariance in the Theory of Superconductivity." *Physical Review* 117, no. 3 (1960): 648–663. The foundational paper on spontaneous symmetry breaking in particle physics, for which Nambu received the 2008 Nobel Prize.

Brout, Robert, and François Englert. "Broken Symmetry and the Mass of Gauge Vector Mesons." *Physical Review Letters* 13, no. 9 (1964): 321–323; Higgs, Peter W. "Broken Symmetries and the Masses of Gauge Bosons." *Physical Review Letters* 13, no. 16 (1964): 508–509. The Brout-Englert-Higgs mechanism: what happens when a local gauge symmetry is spontaneously broken.

Castellani, Elena. "On the Meaning of Symmetry Breaking." In *Symmetries in Physics: Philosophical Reflections*, edited by Katherine Brading and Elena Castellani, 321–334. Cambridge: Cambridge University Press, 2003. Philosophical analysis of the different types of symmetry breaking and their interpretive significance.

### Philosophy of Symmetry and Conservation

van Fraassen, Bas C. *Laws and Symmetry*. Oxford: Clarendon Press, 1989. Argues that symmetry principles have explanatory priority over the laws they generate. Directly relevant to the essay's claim that the invariance of divine command is explanatorily prior to the conservation of obligation.

Lange, Marc. "Laws and Meta-Laws of Nature: Conservation Laws and Symmetries." *Studies in History and Philosophy of Modern Physics* 38, no. 3 (2007): 457–481. Argues that symmetry principles function as "meta-laws" with a higher modal status than ordinary laws. The essay's analogy between Noether's theorem and the structure of taklīf draws on this framework.

Earman, John. "Laws, Symmetry, and Symmetry Breaking: Invariance, Conservation Principles, and Objectivity." *Philosophy of Science* 71, no. 5 (2004): 1227–1241.

Brown, Harvey R., and Peter Holland. "Simple Applications of Noether's First Theorem in Quantum Mechanics and Electromagnetism." *American Journal of Physics* 72, no. 1 (2004): 34–39.

### Uṣūl al-Fiqh: General and Comparative

Hallaq, Wael B. *A History of Islamic Legal Theories: An Introduction to Sunnī Uṣūl al-Fiqh*. Cambridge: Cambridge University Press, 1997. The standard English-language treatment. Essential for the cross-school comparison of qiyās, 'illa, and the mechanisms of legal change.

Kamali, Mohammad Hashim. *Principles of Islamic Jurisprudence*. Third revised edition. Cambridge: Islamic Texts Society, 2003. Comprehensive and accessible. Particularly strong on ta'līl, the conditions for valid qiyās, and the distinction between 'azīma and rukhṣa.

Opwis, Felicitas. *Maṣlaḥa and the Purpose of the Law: Islamic Discourse on Legal Change from the 4th/10th to 8th/14th Century*. Leiden: Brill, 2010. Traces the development of maṣlaḥa theory from al-Juwaynī through al-Shāṭibī, including al-Ṭūfī's radical position. Relevant to the question of what remains invariant when rulings change.

al-Shāṭibī, Abū Ishāq. *al-Muwāfaqāt fī Uṣūl al-Sharī'a*. Edited by 'Abd Allāh Darrāz. 4 vols. Cairo: al-Maktaba al-Tijāriyya, n.d. The most comprehensive classical treatment of maqāṣid al-sharī'a. The tripartite hierarchy of ḍarūriyyāt, ḥājiyyāt, and taḥsīniyyāt is central to the essay's argument about what the invariants of the legal system actually are.

Ibn al-Qayyim al-Jawziyya. *I'lām al-Muwaqqi'īn 'an Rabb al-'Ālamīn*. Edited by Mashhūr Ḥasan Āl Salmān. 7 vols. Dammam: Dār Ibn al-Jawzī, 1423 AH. The passage on rulings that replace justice with injustice, cited in the essay, appears in this work and is one of the clearest classical statements that specific rulings are variable while normative purposes are invariant.

### Ja'farī Uṣūl al-Fiqh

al-Khurāsānī, Ākhūnd Muḥammad Kāzīm. *Kifāyat al-Uṣūl*. Various editions. The capstone Shī'ī uṣūl text, treating both verbal and rational proofs. Over two hundred commentaries have been written on it.

al-Ṣadr, Muḥammad Bāqir. *Durūs fi 'Ilm al-Uṣūl* (also known as *al-Halaqāt*). 3 vols. Beirut: Dār al-Kitāb al-Lubnānī, 1978. Available in English as *Lessons in Islamic Jurisprudence*, translated by Roy Parviz Mottahedeh (Oxford: Oneworld, 2003). Al-Ṣadr's theory of ḥaqq al-tā'a (the right to obedience) as the ground of obligation is directly relevant to the essay's inquiry into what generates the conservation of taklīf.

al-Ṣadr, Muḥammad Bāqir. *al-Usus al-Mantiqiyya li-l-Istiqrā'* (*The Logical Foundations of Induction*). Beirut: Dār al-Ta'āruf, 1972. Al-Ṣadr's epistemological magnum opus, proposing a subjective probability theory as the basis of inductive reasoning. Relevant as background to his distinctive approach to legal epistemology.

Muṭahharī, Murtaḍā. *Jurisprudence and Its Principles*. Translated by Salman Tawhidi. Qom: Anṣāriyān, n.d. Available at al-islam.org. The source of the completeness claim cited in the essay: that no human act is empty of one of the five rulings.

Modarressi, Hossein. *An Introduction to Shī'ī Law: A Bibliographical Study*. London: Ithaca Press, 1984. Indispensable bibliographical orientation to the Shī'ī legal tradition.

Cooper, John. "Intellect and Language: A Study of the Philosophical Foundation of Shī'ī Legal Methodology (Uṣūl al-Fiqh)." DPhil dissertation, University of Oxford. Unpublished but influential. Bridges Western philosophical analysis and the internal logic of Shī'ī jurisprudential reasoning.

### Kalām, Moral Epistemology, and the Metaphysics of Obligation

ʿAbd al-Jabbār al-Hamadhānī, Qāḍī. *al-Mughnī fi Abwāb al-Tawḥīd wa-l-ʿAdl*. 20 vols. Cairo: various editors, 1960s–1970s. The most systematic Mu'tazilī treatment of theology and ethics. Volumes on taklīf and moral obligation are directly relevant.

ʿAbd al-Jabbār al-Hamadhānī, Qāḍī. *Kitāb al-Majmū' fi-l-Muḥīṭ bi-l-Taklīf*. A dedicated treatise on the theory of obligation.

Hourani, George F. *Islamic Rationalism: The Ethics of ʿAbd al-Jabbār*. Oxford: Clarendon Press, 1971. The foundational English-language study of Mu'tazilī ethical objectivism.

Hourani, George F. *Reason and Tradition in Islamic Ethics*. Cambridge: Cambridge University Press, 1985. Broader than the monograph on ʿAbd al-Jabbār. Treats the ḥusn/qubḥ debate across schools and draws comparisons with Western ethical theory.

Vasalou, Sophia. *Moral Agents and Their Deserts: The Character of Mu'tazilite Ethics*. Princeton: Princeton University Press, 2008. A philosophically sophisticated reconstruction of Mu'tazilī moral theory that engages seriously with its internal logic.

## **Selected Bibliography:** *Invariance and Obligation: Noether's Theorem and the Metaphysics of Taklīf*

Frank, Richard M. "Moral Obligation in Classical Muslim Theology." *Journal of Religious Ethics* 11, no. 2 (1983): 204–223. Examines how Ash'arī and Mu'tazilī theologians understood the relationship between divine command and moral obligation.

Hare, John E. *God's Command*. Oxford: Oxford University Press, 2015. Chapter 6 treats Islamic divine command theory across Mu'tazilī, Ash'arī, and Māturīdī positions, with particular attention to al-Māturīdī's synthesis. The source of the characterisation cited in the essay about al-Māturīdī's two-source epistemology.

Shihadeh, Ayman. "The Existence of God." In *The Oxford Handbook of Islamic Theology*, edited by Sabine Schmidtke, 197–217. Oxford: Oxford University Press, 2016. Useful for the broader theological context in which debates about the ontology of obligation are situated.

Rudolph, Ulrich. *Al-Māturīdī and the Development of Sunnī Theology in Samarqand*. Translated by Rodrigo Adem. Leiden: Brill, 2015. The standard intellectual biography, essential for understanding the Māturīdī position on reason, revelation, and moral epistemology.

### **Islam, Science, and Kalām Atomism**

Altaie, Basil. "Re-examination of the Concept of Atomism in Islamic Theology." *Arabic Sciences and Philosophy* 28, no. 2 (2018): 225–266. Argues that the mutakallimūn held space, time, and motion to be discrete at their foundations. Directly relevant to the essay's discussion of the continuous/discrete problem: if kalām already understands physical reality as fundamentally discrete, the fracture point in the Noether analogy may reveal something about the kalām tradition's own ontological commitments.

Guessoum, Nidhal. *Islam's Quantum Question: Reconciling Muslim Tradition and Modern Science*. London: I.B. Tauris, 2011. A survey of contemporary Muslim engagement with physics, including discussions of symmetry, fine-tuning, and the relationship between scientific and theological modes of explanation.

Golshani, Mehdi. "Philosophy of Science from the Qur'anic Perspective." In *God, Life, and the Cosmos: Christian and Islamic Perspectives*, edited by Ted Peters, Muzaffar Iqbal, and Syed Nomanul Haq, 71–90. Aldershot: Ashgate, 2002. Representative of the tradition of Islamic philosophy of science within which the essay's cross-domain reasoning is situated.

### **Wilāya and Authority**

Sachedina, Abdulaziz Abdulhussein. *The Just Ruler in Shī'ite Islam: The Comprehensive Authority of the Jurist in Imamite Jurisprudence*. New York: Oxford University Press, 1988. The standard English treatment of the historical development of political authority in Shī'ī thought, from the Imams through the theory of wilāyat al-faqīh.

Calder, Norman. "Accommodation and Revolution in Imami Shi'i Jurisprudence: Khumayni and the Classical Tradition." *Middle Eastern Studies* 18, no. 1 (1982): 3–20. Situates Khomeini's theory of absolute wilāyat al-faqīh within the longer trajectory of Shī'ī legal thought.

**Selected Bibliography:** *Invariance and Obligation: Noether's Theorem and the Metaphysics of Taklīf*

Gleave, Robert. *Inevitable Doubt: Two Theories of Shī'ī Jurisprudence*. Leiden: Brill, 2000. On the Uṣūlī-Akhbārī debate. Essential for understanding why the Uṣūlī victory, and with it the preservation of 'aql as a source of law, matters for the essay's argument.

**SMRH**

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