

ŁUKASIEWICZ, JAN (b. Lvov, Austrian Galicia [now Ukrainian S.S.R.], 21 December 1878; d. Dublin, Ireland, 13 February 1956), *mathematical logic*.

Łukasiewicz's father, Paul, was a captain in the Austrian army; his mother, the former Leopoldine Holtzer, was the daughter of an Austrian civil servant. The family was Roman Catholic, and the language spoken at home was Polish. Young Łukasiewicz studied mathematics and philosophy at the University of Lvov, earning his doctorate *sub auspiciis imperatoris*, a rare honor (1902). At the same institution he received his *Habilitation* (1906) and lectured in logic and philosophy, as *Privatdozent* until 1911, then as extraordinary professor. In 1915 Łukasiewicz accepted an invitation to lecture at the University of Warsaw, then in German-occupied territory.

Between the world wars, as a citizen of independent Poland, Łukasiewicz was minister of education (1919), professor at the University of Warsaw (1920–1939), twice rector of that institution, an active member of scientific societies, and the recipient of several honors. He and Stanisław Leśniewski founded the Warsaw school of logic, which A. Tarski helped make world famous. Viewing mathematical logic as an instrument of inquiry into the foundations of mathematics and the methodology of empirical science, Łukasiewicz succeeded in making it a required subject for mathematics and science students in Polish universities. His lucid lectures attracted students of the humanities as well.

The sufferings endured by Łukasiewicz and his wife (the former Regina Barwinska) during World War II are poignantly recalled in an autobiographical note. (See Sobociński's "In Memoriam," cited below.) In 1946 Łukasiewicz, then an exile in Belgium, accepted a professorship at the Royal Irish Academy, Dublin, where he remained until his death.

After some early essays on the principles of non-contradiction and excluded middle (1910), Łukasiewicz arrived by 1917 at the conception of a three-valued propositional calculus. His subsequent researches on many-valued logics is regarded by some as his greatest contribution. He viewed these "non-Aristotelian" logics as representing possible new ways of thinking, and he experimented with interpreting them in modal terms and in probability terms. The nonstandard systems he developed have value independently of the philosophy that inspired them or of the usefulness of those interpretations. Łukasiewicz created the elegant "Łukasiewicz system" for two-valued propositional logic and the parenthesis-free "Polish notation."

The metalogic (a term he coined on the model of Hilbert's terminology) of propositional calculi, notably

the theory of their syntactic and semantic completeness, owes much to Łukasiewicz and his school. He regarded these studies as a prelude to analogous investigations for the rest of logic, which were then carried out by Tarski.

Using modern formal techniques, Łukasiewicz reconstructed and reevaluated ancient and medieval logic. Through his work in this area, we have changed our view of the history of logic.

During his last years in Ireland, Łukasiewicz published important studies on modal and intuitionistic logic, and he again made logical history with a detailed and novel study of Aristotle's syllogistic. Essentially he interpreted syllogisms in Aristotle to be theorems of logic, not rules of derivations.

BIBLIOGRAPHY

I. ORIGINAL WORKS. Most of Łukasiewicz's contributions were first presented in short notes, often in Polish, or in his university lectures. A list of all, or almost all, of his publications is appended to Andrzej Mostowski's "L'oeuvre scientifique de Jan Łukasiewicz dans le domaine de la logique mathématique," in *Fundamenta mathematicae*, **44** (1957), 1–11. His following writings present important results systematically: *Elementy logiki matematycznej* ("Elements of Mathematical Logic"; Warsaw, 1929; 2nd ed., 1958), translated by Olgierd Wojtasiewicz as *Elements of Mathematical Logic* (New York, 1963); "Philosophische Bemerkungen zu mehrwertigen Systemen des Aussagenkalküls," in *Comptes rendus des séances de la Société des sciences et des lettres de Varsovie*, Cl. III, **23** (1930), 51–77, written with Alfred Tarski; "Untersuchungen über den Aussagenkalkül," *ibid.*, 30–50; "Zur Geschichte der Aussagenlogik," in *Erkenntnis*, **5** (1935–1936), 111–131; "A System of Modal Logic," in *Journal of Computing Systems*, **1** (1953), 111–149; and *Aristotle's Syllogistic From the Stand-Point of Modern Formal Logic*, 2nd ed. (Oxford, 1957).

II. SECONDARY LITERATURE. The following two articles jointly constitute a valuable survey of Łukasiewicz's life-work as a logician, philosopher, and historian of logic: L. Borkowski and J. Stupecki, "The Logical Works of Jan Łukasiewicz," in *Studia logica*, **8** (1958), 7–56; and Tadeusz Kotarbiński, "Jan Łukasiewicz's Works on the History of Logic," *ibid.*, 57–62. Shorter general treatments of Łukasiewicz's work are the Mostowski article cited above; Bolesław Sobociński, "In Memoriam Jan Łukasiewicz," in *Philosophical Studies* (Maynooth, Ireland), **6** (1956), 3–49, which contains an autobiographical note, "Curriculum vitae of Jan Łukasiewicz," and a bibliography; and Heinrich Scholz, "In Memoriam Jan Łukasiewicz," in *Archiv für mathematische Logik und Grundlagenforschung*, **3** (1957), 3–18, which contains an excellent summary of the technical aspects of Łukasiewicz's contributions.

Łukasiewicz's exegesis of Aristotle's syllogistic is disputed in Arthur N. Prior, "Łukasiewicz's Symbolic Logic," in *Australasian Journal of Philosophy*, 30 (1952), 33–46, and is discussed in Gunther Patzig, *Die Aristotelische Syllogistik: Logisch-philologische Untersuchungen über das Buch A der "Ersten Analytiken"* (Göttingen, 1959); English trans. by J. Barnes, *Aristotle's Theory of the Syllogism: A Logico-philological Study of Book A of the Prior Analytics* (Dordrecht, 1968), *passim*, esp. 196–202.

For a general evaluation of Łukasiewicz's philosophical and logical ideas, see Henryk Skolimowski, *Polish Analytical Philosophy: A Survey and a Comparison with British Analytical Philosophy* (New York, 1967), 56–72.

GEORGE GOE

LULL, RAMON (*b.* Ciutat de Mallorca [now Palma de Mallorca], *ca.* 1232; *d.* Ciutat de Mallorca [?], January/March [?] 1316), *polymathy*.

A Catalan encyclopedist, Lull invented an "art of finding truth" which inspired Leibniz's dream of a universal algebra four centuries later. His contributions to science are understandable only when examined in their historical and theological context. The son of a Catalan nobleman of the same name who participated in the reconquest of Mallorca from the Moors, Lull was brought up with James the Conqueror's younger son (later crowned James II of Mallorca), whose seneschal he became. About six years after his marriage to Blanca Picany (1257) he was converted from a courtly to a religious way of life, following a series of visions of Christ crucified. He never took holy orders (although he may have become a Franciscan tertiary in 1295), but his subsequent career was dominated by three religious resolutions: to become a missionary and attain martyrdom, to establish colleges where missionaries would study oriental languages, and to provide them with "the best book[s] in the world against the errors of the infidel."¹

Lull's preparations lasted a decade; his remaining forty years (from 1275, when he was summoned by Prince James to Montpellier, where he lectured on the early versions of his Art) were spent in writing, preaching, lecturing, and traveling (including missionary journeys to Tunis in 1292; Bougie, Algeria, in 1307; and Tunis late in 1315), and in attempts to secure support from numerous kings and four successive popes for his proposed colleges. During Lull's lifetime only James II of Mallorca established such a foundation (1276, the year of his accession); when he lost Mallorca to his elder brother, Peter III of Aragon, the college at Miramar apparently was abandoned (*ca.* 1292). In Lull's old age his proposals were finally approved by the Council of Vienne

(1311–1312); and colleges for the study of Arabic, Hebrew, and Chaldean were founded in Rome, Bologna, Paris, Salamanca, and Oxford after Lull's death. Pious tradition has it that he died after being stoned by Muslims in Bougie (January 1316[?]), although his actual death is variously said to have occurred in Bougie, at sea, or in Mallorca; modern scholars doubt the historicity of his martyrdom. As for his third resolution, it led to the various versions of Lull's Art—and all his scientific contributions were by-products of this enterprise.

James the Conqueror's chief adviser, the Dominican Saint Ramon de Penyafort, dissuaded Lull from studying in Paris, where his age and lack of Latin would have told against him; he therefore studied informally in Mallorca (1265[?]-1273[?]). His thought was thus not structured at the formative stage by the Scholastic training which molded most other late medieval Christian thinkers; this fostered the development of his highly idiosyncratic system by leaving his mind open to numerous non-Scholastic sources. These included cabalism (then flourishing in learned Jewish circles in both Catalonia and Italy), earlier Christian writers discarded by Scholasticism (for instance, John Scotus Eriugena, whose ninth-century *De divisione naturae* influenced Lullian cosmological works, notably the *Liber chaos*, either directly or indirectly—and hence also his Art), and probably also Arabic humoral medicine and astrology. The Augustinian Neoplatonism of the Victorines also proved important, partly because of its continuing prominence but mainly because its marked coincidences with both Islamic and cabalistic Neoplatonism favored the creation of a syncretistic system which was firmly grounded in doctrines equally acceptable to Christians, Jews, and Muslims.

This fusion occurred after the eight years Lull spent in Mallorca studying Latin, learning Arabic from a slave, reading all texts available to him in either tongue, and writing copiously. One of his earliest works was a compendium of the logic of al-Ghazālī in Arabic (1270[?]); it has since been lost, although two later compendia with similar titles survive—one in Latin, the other in Catalan mnemonic verse. In all, Lull wrote at least 292 works in Catalan, Arabic, or Latin over a period of forty-five years (1270–1315); most of them have been preserved, although no Arabic manuscripts have yet been traced and many Catalan and Latin works remain unpublished. His initial awkwardness in Latin, coupled with his desire that knowledge be made available to non-Latin-speaking sectors of society, made Lull the first person to mold Catalan into a literary medium. He used it not only in important mystical works, poetry, and allegorical