



Rinat Magdievich Nugayev (Nugaev, Nougayev)

[Ринат Магдиевич Нугаев]

Scientific Degree: Doktor Philosophskikh Nauk (doctor of philosophy)

Academic Rank: Full Professor.

The direction of research: history & philosophy of physics, philosophy of science, sociology of science, history of science, epistemology, general relativity, black holes' physics, quantum field theory in curved spacetimes.

Nugayev Rinat Magdievich (born on May 30, 1953 in Kazan), doctor of philosophy (1991), full professor (1993). Title of honored scientist of the Republic of Tatarstan (2003), a member of the British Society for the Philosophy of Science (1985), American Philosophy of Science Association (1985), American Physical Society (1993), New York Academy of Sciences, an associate member of Russian Academy of Natural Sciences (2011). A member of the Academic Committee of “*Physical Interpretation of Relativity*” international conference (London, UK). A member of the Editorial Board of “*Philosophy of Science*”, an international journal published by University of Chicago Press. Participated in the international congresses in Kazan, Moscow, Saint-Petersburg, Minsk, London, Uppsala (Sweden), Ulm (West Germany), international seminars in Dubrovnik (Croatia) and Bloomington (USA), international conferences in Indianapolis (USA), Kirdjali (Bulgaria) and Warsaw (Poland).

On graduating (1970) Kazan gymnasium № 18 (10-year basic English course +3-year course of English literature) Nugayev joined the KSU (Kazan State University) physics department. His major university disciplines were Riemannian geometry and general relativity. Nugayev's diploma paper was devoted to the refutation of a nonmetric theory of gravity. On graduating from the KSU Nugayev studied relativistic astrophysics at Moscow Institute of Space Research of Russian Academy of Science (Ya. B. Zel'dovich & I.D. Novikov research group; 1975-76).

After graduating from KSU and MSU he gets his M. Sci degree at Moscow State University. The theme of his ‘**kandidatskaya**’ dissertation was “Occurrence

and Resolution of Theory-Choice Situations in Physics” (1979, dept. of philosophy of science, Philosophical Faculty, Moscow State University). The theme of his ‘**doktorskaya**’ dissertation was “Reconstruction of Mature Theory Change” (1991, dept. of philosophy of science, Moscow Institute of Philosophy, Russian Academy of Science).

In 1983 Nugayev’s short paper “*Special Relativity as a Step in the Development of Quantum Theory*” was published in the volume of Soviet papers prepared by the Moscow Institute of Philosophy for the VII International Congress on Logic, Methodology, and Philosophy of Science (Saltzburg, Austria). The paper arose interest among the participants, as the approving letters from Karl R. Popper and Paul K. Feyerabend testify (see also *BJPS*, 1985, vol.36, pp.149-179; P.K. Feyerabend. *Against Method*, third edition. L.: Verso, 1993).

In 1982 he joined the KSU teaching staff to lecture on the philosophy of science, logic, and epistemology and in 1993 was elected a KSU full professor. In 1989 his opus magnum “*Reconstruction of Fundamental Theory Change*” (scientific editor acad. Vyacheslav S. Stepin) was published in Russian by Kazan University Press. (Its Western analogue “*Reconstruction of Mature Theory Change: A Theory-Change Model*” was published in English by Peter Lang, Frankfurt, in 1999, scientific editor prof. James R. Brown).

In 2000-01 he had worked as an RSEP research fellow at the department of history & philosophy of science, Indiana University, Bloomington, the USA under the kind supervision of Professor Emeritus Noretta Koertge. In 1996-2003 Nugayev plied as a head of the dept. of philosophy & sociology at Tatarstan Academy of Science.

Rinat Nugayev lectured on philosophy & history of science for graduates and applicants at several Kazan universities including Kazan Medical, Technical, Technological, and Cooperation Universities, as well as on philosophy in English online for students of IT Park University, Tashkent. Nugayev R.M. was a supervisor of seven ‘kandidatskaya’ dissertations on philosophy and sociology of science.

In 2000-2003 he was awarded President Yeltsin’s personal stipend as ‘an outstanding scientist of Russia’. He received research grants from Tatarstan Academy of Science, Russian Ministry of Education, and Russian Foundation for Basic Research (1997, 2003), as well as travel grants from Soros Foundation (1991, 1993, 1995, 1997) and RSEP (the USA, 2000-2001).

Nugayev's multilateral research and its main results.

(I) Nugayev's **first** scientific findings had been related to empirical verification of the tensor linear nonmetric theory of gravity (1975). In his diploma design (together with his scientific advisor Dr. Ranat F. Bilyalov) he exhibited that the nonmetric theory was in stark contrast to the Weak Principle of Equivalence well-corroborated by the Eotvos and Braginsky reliable and precise experiments. Eventually the problem situation elicited (once more!) all the risks of the unlimited math speculations not constrained by the physically meaningful reasoning.

(II) Hence Nugayev's **second** research realm turned out to be connected with Moscow Institute of Space Research (Russian Academy of Science) and acad. Ya.B. Zel'dovich and I.D. Novikov relativistic astrophysics& cosmology research group. Namely there he delved into black holes' physics trying to answer the thrilling question "What does the Universe look like to an observer located near a non-rotating black hole?" (*Russian (Soviet) Physics Journal*", vol.20, number 9, September 1977).

(III) Accordingly, he started to be grappled hard with the empirical justification of the **particle creation of the black holes**. Forsooth, Stephen Hawking's startling 1974 results had been often criticized for the hackup of two inter-contradictory mature theories : general relativity and quantum field theory. However, it is well-known, thanks to Henri Poincarè, that the theory grounded on the inconsistent principles can provide *any* result.

Hence, on the one hand Nugayev had been doing his best to establish the links of the *Hawking effect* with the Casimir (static and dynamic) ones, as his publications in "*Physics Letters*" (1979, 1982), "*Astrophysics & Space Science*" (1983), "*Communications in the Mathematical Physics*" (1987), "*Physical Review D*" (1991), etc., witness. Eventually, he adumbrated the synthetic scientific research program of scrutinizing the Hawking effect which complied with flexible principles of Lakatosian methodology of scientific research programs contriving a chain of ideal models mimicking the various facets of the evaporation process with

increasing precision.

On the other hand, Stephen Hawking justly called the problem of unification of relativistic and quantum principles “the central problem posed by the advancement of physics”. The problem inexorably raised the question of what a genuine fusion of mature theories should be and of the working out an epistemological model of mature theories synthesis based not only on the reasonable methodological considerations, but on extensive and reliable history of physics studies as well.

(IV) Not by chance Nugayev’s research interests gradually changed for history & philosophy of physics, philosophy and sociology of science, and beyond for epistemology. Since mature theory unifications lie at the core of the radical revolutions in science (Copernicus, Maxwell, Planck, Einstein), eventually Nugayev set forth a perspicuous **model of mature theory change**. The epistemic model drew upon some domestic insights (Vyacheslav Stepin, Elena Mamchur, V.I. Arshinov, V.S. Schwyrev, V.P. Bransky, M.I. Podgoretzky, Ya. A. Smorodinsky, Ya. B. Zel’dovich, I.D. Novikov, I. Yu. Kobzarev, N.I. Kuznetsova, S.V. Illarionov), as well as some Western concepts (K. R. Popper, P.K. Feyerabend, I. Lakatos, A. Koyré, T. S. Kuhn, P. Galison, I. Hacking, H. Putnam, L. Tisza, Stephen G. Brush, N. Cartwright, L. Laudan, N. Maxwell, M. Morrison, S. Goldberg, J. Illy, D. Papineau, A. Pickering, D. Siegel, J. van Dongen, T. Ryckman, J. Worrall, E. Zahar, et al.) The crux of the model consists in the surmise that to comprehend the true origins of scientific revolutions one has to take into account not habitual clashes of mature theories with ‘facts’ only, but first and foremost of ‘old’ mature research traditions *with each other*. They lead to profound contradictions than can only be (partly) smoothed or even eliminated by traditions’ reconciliation, interpenetration, and intertwinement.

In good sooth, the previous skillful accounts of scientific revolutions have intensely oscillated between *two alternative extremes*. On the one hand, in the logical empiricism stout vein, the apparent differences between research

traditions were hastily taken to be *insignificant* and fruitful communication (and even deep interpenetration) unproblematic. On the other hand, in the new-fangled, post-Kuhnian distinctive disquisitions, important differences between the research traditions are commonly exhibited to be so *radical* that their actual communication is regarded almost impossible (the celebrated ‘incommensurability tenet’).

Nugayev’s blunt account stems discreetly from a more common and ordinary *intermediate picture*. Respectively, he readily admits that the substantial differences between the research traditions really existed at the various levels, ranging from entrenched ontological commitments and up to inextricable epistemological beliefs. Nevertheless, these often antagonistic traditions were able to *communicate* fruitfully in the creative acts of such pandits as Ptolemy, the Arab Muslim astronomers of the Maragha school, Copernicus, Galileo, Descartes, Kepler, Newton, Maxwell, Planck, Einstein, Bohr, Pauli, Heisenberg, Dirac, Hawking, Witten, and some others. The research traditions had vigorously communicated by the subtle ways that permitted comparisons, adaptations, and even fruitful *cross-fertilizations*.

The intermediate humble approach originates from the principled criticism of the ‘one-sidedness’ of Kuhnian and Lakatosian the most advanced epistemological models: they both as a matter of fact (yet due to different epistemological reasons) lack the subtle mechanisms of the paradigms’ (or scientific research programs’) intense *interactions* (see Nugayev R.M. “*The British Journal for the Philosophy of Science*”, 1985; “*Philosophy of Science*”, 1985).

Respectively, the profound origins of scientific revolutions are fathomed in the stiff collisions of 'old' pivotal research traditions with each other. The latter transpires in relentless contradictions that *can* be most effectively (yet not always!) excluded in a more general (‘global’) theory. Whereupon, the leading parts in mature theory change are played not merely by the intense *dialogues* of the proponents of the old paradigms' that may lead to mutual accommodation and even profound interpenetration of the participants' s views. Rather, the more important

factor turns out to be the “apartness” of a Scientific Revolutionary in respect to the entrenched paradigms of the classical heritage. For instance, Einstein’s anti-dogmatism (“apartness”) turned out a crucial hallmark of his basic engineering education (Zurich Polytechnic) and corresponding scientific style of reasoning. It enabled a young man to comprehend and to compare objectively the conceptual implications in the works of such pandits as Lorentz, Hertz, Poincaré, and Planck that they were sometimes unable to discern. Unsurprisingly in their Proposal for Einstein’s Membership in the Prussian Academy of Science (Berlin, 12 June 1913), M. Planck, W. Nernst, H. Rubens, and E. Warburg maintained that “Apart from his great productivity, Einstein has a special talent for getting to the bottom of *other* scientists’ newly emerging views and assertions, and for assessing their *relationship to each other* and to experience with surprising certainty”.

It was sedulously displayed that the global theory piecemeal contrivance is being incessantly dominated by hard internal tensions between the 'old' well-established scientific research programs. Viz., the inevitable encounter of the stout programs, their deep interpenetration, and strong twisting provide the erection of a vast hybrid realm at first with a haphazard throng of crossbred theoretical models. Gradually, on consecutive soothing and eliminating the contradictions between the hybrid models, the crossbred solid system is sedulously set up.

Up to a point, the abovementioned epistemic model can be taken as proffering a reliable *mechanism* of practically simultaneous drastic transformation of the 'old' paradigms. The hallmark of the sophisticated mechanism is the contrivance of the crossbred systems constructed from the basic theoretical objects of 'old' mellow theories. The crossbred systems constitute cohesive channels through which the accommodation of the 'old' traditions encountered relentlessly commences. The accommodation gradually leads to the installation of a throng of *crossbred* theoretical schemes. It is expected that the hotchpotch will be ultimately processed and subsequently generalized to set up a conspicuous *fine structure* of a

novel global theory (“*Epistemologia*”, 1998; “*Journal of General Philosophy of Science*”, 2007).

Hence Nugayev contends that *profound breakthroughs in science were first and foremost not due to ingenious contrivances of the brave new paradigms or bold invention of startling novel ideas ‘ex nihilo’. On the contrary, the staggering breakthroughs were caused by the harrowing humble processes of piecemeal accommodation, gradual interpenetration, and discreet intertwinement of the ‘old’ pivotal research traditions preceding such radical breaks* (Rinat M. Nugayev. “*Reconstruction of Mature Theory Change: A Theory Change Model*”. Peter Lang Verlag: Frankfurt/M, West Germany, Switzerland, 1999. – 199p.)

(V) Based on the model amended he proposed the so-called “**conception of communicative rationality**” that craves to take the socio-psychological peculiarities of theory change into account. (The conception is grounded on Jurgen Habermas’ doctrine of “*communicative social action*”). The proposed conception enables one to elicit the basic paradigms’ interaction properly, as well as the interaction of cognitive and social facets of the research traditions. The key role in theory change is played now by the proponents of the old paradigms’ *inextricable dialogue* that leads to genuine interactions in all the three main dimensions including personal, institutional (scientific community), and cultural (intertheoretical) aspects (see R.M. Nugayev. ”*Sociology: 4M*”, in Russian; “*Basic Paradigm Change: Communicative Rationality Approach*”. Kazan: The Dom Pechati Publishing House, 2002, in Russian; “*Russian Studies in Philosophy*”, 2002).

(VI) Further, R.M. Nugayev had advanced a spellbinding outlook at the “**Einstein Revolution**” embracing the rational reconstructions of “Lorentz - Einstein” and “Maxwell-Planck” transitions in light of the abovementioned lucid epistemological model. As a main result, it surprisingly turned out that special

relativity genesis can be unfolded as a preliminary stage of quantum theory construction; hence *the true reasons for Einstein's victory over Lorentz cannot be comprehended without Einstein's and his contemporaries' writings on the so-called 'old quantum theory'* (R.M. Nugayev. “Centaurus”,1986; “*Historia Scientiarum*”, 1998; “*Physis*” 2000).

The ultimate aim of the novel outlook at the ‘Einstein Revolution’ was to finally comprehend *why* classical mechanics and classical electrodynamics were ‘refuted’ almost *simultaneously* at the beginning of the XX-th century. Nugayev contended that the Quantum and the Relativistic revolutions were contemporaneous since they apparently had the *common origin* – a tough skirmish between the pivotal research traditions of the second half of the XIX-th century that constituted the ‘body’ of Classical Physics: Newtonian mechanics, Maxwellian electrodynamics, Boltzmann’s statistical mechanics and classical thermodynamics. The revolution’s most dramatic bifurcation points were Planck’s 1900 and Einstein’s 1905 light quantum papers (“*Foundations of Science*”, 1999; “*Metaphysics*”, 2018, in Russian; “*Axiomathes*”, 2019).

Though Einstein's strenuous efforts sprung out of Max Planck's pioneering attempts to comprehend electromagnetic phenomena through the lenses of conceptual structures of statistical thermodynamics. It was Planck, who realized the cross-contradiction between 'the physics of material bodies' and 'the physics of the ether' and outlined the sketch of its withdrawal: the paradigms *'must be modified to remain compatible'*. And it was Planck who took the first step in modifying the physics of the ether and contending that 'not only matter itself but also the effects radiated from matter' possess discontinuous properties'. Einstein's part consisted in that he took masterfully the second step in modifying the second component of the encounter – the physics of material bodies (see Rinat M. Nugayev. “*The Planck-Einstein Breakthrough: Reconciliation of the Pivotal Research Programs of Classical Physics*” (Minkowski Institute Press, Montreal, Canada, 2020).

Einstein's foolhardy light quanta hypothesis and distinctive special theory of relativity turn out to be mere milestones of the unwinding of Maxwellian electrodynamics and statistical thermodynamics reconciliation research program. The notorious conception of luminiferous ether turned out a substantial obstacle for Einstein's wayward statistical thermodynamics in which the pivotal lead was played by flagrant light quanta paper. Einstein was aware that his enticing light quanta hypothesis was too audacious to be taken literally and he laid out his version of 'electrodynamics of moving bodies' in a markedly Machian / Duhemian, phenomenological way. Though his *ultimate* epistemological background was neo-Kantian epistemology (see Rinat M. Nugayev. "*Einstein's Revolution: A Study of Theory Unification*" (Bentham Science Publishers, Sharjah, 2018).

(VII) In his further Einstein studies Nugayev dug out still deeper into the background to unfold that the **dynamics of general theory of relativity** (GTR) construction was predominately governed by internal tensions between special relativity and Newton's gravity research traditions. With the basic crossbred object – the metric tensor - at the top of the edifice, Einstein was able to comprise both the knowledge on gravitation and inertia represented by classical mechanics and the knowledge on the structure of space and time embodied by STR (special theory of relativity).

By and large Einstein's victory over his rivals (Nordström and Abraham) became possible because the core of his research strategy was formed by the so-called 'equivalence principle' comprehended in the light of Kantian epistemology. It was disclosed that the theories of Nordström and Abraham contrived before November 25, 1915, were not merely the scaffolds of GTR basic model construction. They were and still *are* the necessary parts of the whole GTR multifarious theoretical structure indispensable for its common use (*Voprosi Filosofii*, 2017; *Acta Baltica Historiae et Philosophiae Scientiarum*, 2018). Notwithstanding Einstein's stupendous impact, the contributions of Nordström,

Abraham, Grossmann, Hilbert, Laue, Lorentz, Poincaré, Besso, Fokker, and others should be taken into account (“*Kairos*”, 2018).

(VIII) An outlook of the **XVII century Scientific Revolution** has been elaborated and rational reconstruction of the ‘Ptolemy-Copernicus’ inextricable transition in the wake of Alexander Koyré’s epistemological tradition was worked out. The germ of an idea is drawn upon the ‘fact’ that Newton’s classical mechanics resulted in (partial) unification of two disparate subjects developed independently: ‘Mundane Physics’ and ‘Divine Mathematics’. Whereupon, the Copernican Revolution was elicited in the distinctive context of intense *interaction* of Aristotelean and Ptolemaic subtle theoretical languages. It was unfolded that already within the Ptolemaic research program the mathematical exactness increasingly deviated from the blunt tenets of Aristotelean qualitative physics. Aristotelian – Ptolemaic pagan cosmology could not help but be exposed to repeated cogent attacks during the Middle Ages since it confronted the principles of monotheism not admitting the stiff and impervious demarcation line between the celestial and mundane realms. All different worlds should have the same Creator. Starting the unification, Copernicus in effect paved the way for Galileo’s and Newton’s drastic mathematical physics (see R.M. Nugayev. “*The Copernican Revolution: Unification of Mundane Physics and Mathematics of the Skies*” (in Russian, Kazan: Logos Publication Group, 2012; *Almagest* 2013; *Philosophy International Journal* 2021).

(IX) Grounded on the epistemological theory-change model the genesis of “**quantum theory in curved space-times**” was scrutinized in the connection with some unification processes taking part in theories of supersymmetry and superstrings (see the corresponding chapter of Rinat M. Nugayev. “*The Planck-Einstein Breakthrough: Reconciliation of the Pivotal Research Programs of Classical Physics*”, Minkowski Institute Press, Montreal, Canada, 2020).

(X) An outlook of the **Maxwellian scientific revolution** has been elaborated seen through a cognitive lens of the lucid epistemological model. It is unfolded that in the case considered a genuinely new theory was constructed as a result of the old pre-Maxwellian programs reconciliation: the electrodynamics of Ampère-Weber, the wave theory of Fresnel and Young and Faraday's distinctive program. The "neutral language" aimed at comparison of the consequences of the theories from these programs consisted in the blunt language of hydrodynamics with its rich content of analogous models ranging from the incompressible fluid up to molecular vortices. The programs' encounter led to the construction of the whole hierarchy of crossbred objects beginning from the displacement current and up to common hybrids. Later on, the interpenetration of the pre-Maxwellian programs began that marked the beginning of theoretical schemes of optics and electromagnetism actual unification. Maxwell's program did assimilate some ideas of the Ampère-Weber program, as well as the presuppositions of the programs of Fresnel and Faraday; and the significance of this fact for the further methodology of scientific research programs development is discussed.

The arguments were strengthened in favor of the tenet that the core of Maxwell's unification strategy was formed by Kantian epistemology apprehended through the cognitive lens of William Whewell and such conspicuous representatives of Scottish Enlightenment as Thomas Reid and William Hamilton. All the aforementioned enabled Maxwell to commence to embrace not only optics and electromagnetism but British and continental research traditions as well. Maxwell's program did supersede the Ampère-Weber one because Maxwell did put forward as a synthetic principle the idea, that differed from that of Ampère-Weber by its flexible and contra-ontological, strictly epistemological, Kantian purport. For Maxwell, ether was not the last notorious building block of physical reality, from which fields and charges should be constructed. 'Action at a distance', 'incompressible fluid', 'molecular vortices' were merely models for Maxwell, capable only to direct the researcher on the "right" mathematical relations. From a stale "representational" point of view, all these shallow

hydrodynamical models were doomed to failure efforts to describe what cannot be pictured in principle – things in themselves, the ‘nature’ of electrical and magnetic phenomena. On the contrary, Maxwell aimed his program to elicit empirically meaningful mathematical relations between the electrodynamics basic objects, i.e. the creation of an inter-coordinated electromagnetic field equations system (see R.M. Nugayev. “*Maxwellian Scientific Revolution: Reconciliation of Research Programs of Fresnel, Ampère-Weber and Faraday*”, in Russian. – Kazan: Kazan State University Press, 2013; Logos & Episteme 2014; Foundations of Science 2015).

Namely, implementing the above-mentioned epistemology enabled Hermann von Helmholtz and his star pupil Heinrich Hertz to arrive at such a version of Maxwell’s theory that served as a heuristic basis for the radiowaves discovery.

(XI) One of the distinctive episodes of the history of the XX th century physics – Paul Dirac’s startling contrivance of the relativistic theory of the electron – was scrutinized in the context of lucid epistemological mature theory- unification model. The peculiar character of **Dirac’s synthesis of special relativity and quantum mechanics** was envisaged by comparison with Einstein’s sophisticated methodology of the General Relativity contrivance. The fine structure of Dirac’s scientific research program and first and foremost the odd principles that put up its powerful heuristics was scrutinized with special emphasis on the highly controversial tenet of ‘*mathematical beauty*’. It is contended that despite the relentless Dirac’s remarks denigrating the role of philosophy one can trace its indirect influence epitomized in transcendental idealism and even *Husserlian epistemology* through Arthur Eddington’s and Hermann Weyl’s whimsical mathematical writings embracing their pioneering efforts to merge gravitation with electromagnetism. Accordingly, the milestones of Dirac’s research program realization in the distinctive context of the applied epistemological doctrine are

elicited (see Nugayev's papers in "*Filosofia Nauki I Tekhniki*", in Russian, 2021 and "*Teorie Vedy*"/Theory of Science, 2022).

(XII) The lucid theory-change epistemological model approbated on the history of science stuff embracing the genesis of Maxwellian electrodynamics, Einstein's theories of relativity, and Dirac's relativistic theory of electron was applied to *elucidate* how the theory of **electroweak interactions** relentlessly grew out of the theories of electromagnetism and weak nuclear interactions encounter. Correspondingly, the pivotal thesis of the approach is that there were sound reasons that made a synthesis *necessary*, and, first and foremost, the defiant problem of *renormalization* which guided the research activity from the very beginning to the end. The desired renormalizability of the electroweak theory turned out to be intimately bound up with its unity. Consequently, it is shown off how the U(1) and SU(2) symmetry groups governing the electromagnetic interactions had been tentatively combined into a larger U(1) x SU(2) symmetry, as opposed to reducing the particles and forces to a common source. Ultimately, the unity had been achieved not by simply conjoining the two theories and symmetry groups but by inserting substantially novel components to the pre-existing theories of weak and electromagnetic interactions.

It was contended that this genesis of the electroweak theory is a case of 'reductionist-synthetic' unification. It is a synthetic unification in the sense that the mature theory artfully combines the main features of different theories. It is reductionist in the sense that the theory was formulated in a more encompassing gauge group than the two previous theories.

Nevertheless, the unification was not *complete* because a pivotal parameter of the new theory (the notorious Weinberg angle) remained a free one . A current tenet according to which the electroweak theory itself does not fully account for how the fields are mixed by furnishing direct values for the Weinberg angle, i.e., the electroweak theory does not determine in any strict sense that the fields *must* be mixed is disputed. Nevertheless, it is contended that in many important respects the

hybrid nature of the Weinberg-Salam model engenders its unfinished nature (*'Filosofia Nauki i Tekhniki'*, in Russian, 2020)

(XIII) A subtle **Methodology of Rival Social Science Research Programmes** was elaborated (based on Max Weber's and Imre Lakatos's cogent ideas) aimed at the description of the growth of knowledge in social science & humanities (*'Filosofia Nauki.Novosibirsk'*, 2006, in Russian). The Methodology enables to re-evaluate the connections between their ideological and cognitive parts. The real growth of knowledge unsurprisingly consists in the growth of stout causal explanations and the corresponding growth of empirical content of the theories from superseding scientific research programs (*'Voprosi Filosofii'*, 2007).

(XIV) Nugayev takes part together with his post-graduates and doctorates in scrutinizing the innovation potential, values, the way of life, and dynamics of the various strata of Tatarstan scientific community: the groups of natural and social scientists, the groups of youngsters and old folks, and the groups of unappreciated scientific women.

Not by chance, Nugayev had participated in the elaboration of various regional models of socio-economic development conceptual foundations. Together with his co-workers from Tatarstan Academy of Science sociology & philosophy dept. he took part in the investigations of regional **social potential, quality and way of life**, the possible ways of **modernization**, health care reform, social protection, basic values and regional ideologies, gender problems of the scientific community, etc. (see Nugayev's papers in *"Sociological Researches"*, 1998, 2003, and *"Knowledge, values, and ideologies in modernizing society: interdisciplinary approach"* (co-authors: M.A. Nugaev, A.B. Madiarov, Kazan: The Dom Pechati Publishing House, 2002, in Russian; *"Social Unconsciousness in the Structure of Public Ideologies"* (in Russian; Moscow: Russian University of Cooperation, 2008).

Publications.

He published more than 300 papers in the scientific journals of Russia, Ukraine, Belorussia, USA, Great Britain, Germany, Spain, Italy, Sweden, Switzerland, Netherlands, Canada, Denmark, Estonia, Poland, Romania, France, Greece, Japan, Czech Republic and some other countries (see Google Scholar account <https://scholar.google.com/citations?user=uZXO2jIAAAAJ&hl=en> ; <https://sportacadem.academia.edu/RinatNugayev> and www.philpapers.org for details). Among them are publications in the collective volumes of Moscow Institute of Philosophy, Moscow University and Moscow Institute for History of Natural and Technical Science (Russian Academy of Science), in Russian journals “*Voprosi Filosofii*” (“The Problems of Philosophy”), “*Filosofskie Nauki*”, “*Philosophy of Science*” (Novosibirsk), “*Philosophy of Science and Technology*” (Moscow), “*History of Science & Technology*”, “*Analytica*”, “*Religion Studies*”, “*Science Studies*”, “*Sociologicheskie Issledovania*” (SOCIS), “*Social Sciences and Modernity*”, “*Sociology: 4 M*”, “*Social and Human Science*”, “*Social and Philosophical Thought*” (Ukraine), “*Russian Physics. Izvestiya*”, “*The Culturological Journal*”, “*Credo New*”, etc.

R.M. Nugayev published in some Western journals too, viz. “*The British Journal for the Philosophy of Science*”, “*Philosophy of Science*”, “*International Studies in the Philosophy of Science*”, “*Journal for General Philosophy of Science*”, “*Epistemologia*”, “*Russian Studies in Philosophy*”, “*Centaurus*”, “*Physis*”, “*Foundations of Science*”, “*Historia Scientiarum*”, “*Theoria and Historia Scientiarum*”, “*The Physical Review*” D, “*Communications in Mathematical Physics*”, “*Zeitschrift fur Naturforschung*”, “*Physics Letters*”, “*Nuovo Cimento*”, “*Lettere il Nuovo Cimento*”, “*Scientia*”, “*Astrophysics and Space Science*”, “*International Journal of Theoretical Physics*”, “*Annales de la Fondation Louis de Broglie*”, “*Archives des Sciences*”, “*Logos and Episteme*”, “*Almagest*”, “*Spontaneous Generations*”, “*Kairos*”, philsci-archive.pitt.edu, “*Acta Baltica Historiae et Philosophiae Scientiarum*”, “*Axiomathes*”, “*Teorie Vedy*”.

Nugayev's main monographs.

1. **“Reconstruction of Fundamental Theory Change ”** (in Russian, 208 pp.; Kazan State University Press, 1989). Reviewed in philosophy & history of science journals of Russia, Belorussia, Ukraine, Poland, Italy, Germany, and the USA. Translated by the author into English in: *“Methodology and Science”* (Haarlem, the Netherlands), 1995, vol. 28, №№ 1,2,2/3.
2. **“Reconstruction of Mature Theory Change: A Theory Change Model”** (in English,- Peter Lang Verlag, Frankfurt/M, West Germany, Switzerland - 1999 - 199pp. US-ISBN. 0-8204-3627-5. Reviewed in the philosophy of science and history of science journals of Poland, Italy, Denmark, England, Germany, and the USA.
3. **“Knowledge, values, and ideologies in modernizing society: interdisciplinary approach”** (co-authors: M.A. Nugaev, A.B. Madiarov, Kazan: The Dom Pechati Publishing House, 2002. -159 pp., in Russian).
4. **«Basic Paradigm Change: Communicative Rationality Approach»**. (Kazan: The Dom Pechati Publishing House, 2002. –300 pp., in Russian).
5. **“Social Unconsciousness in the Structure of Public Ideologies”** (in Russian; 202 pp. –Moscow: Russian University of Cooperation, 2008).
6. **“Einstein’s Revolution: Interdisciplinary Context”** (in Russian; 312pp. – Kazan: Logos Publication Group, 2010).
7. **«The Copernican Revolution: Unification of Mundane Physics and Mathematics of the Skies»** (in Russian, 302 pp.- Kazan: Logos Publication Group, 2012).
8. **“Maxwellian Scientific Revolution: Reconciliation of Research Programs of Fresnel, Ampère-Weber and Faraday** (in Russian, 183pp. – Kazan: Kazan State University Press, 2013).
9. **“Einstein’s Revolution: A Study of Theory Unification”** (in English; Bentham Science Publishers, 2018. – 204 pp.)
10. **“The Planck-Einstein Breakthrough: Reconciliation of the Pivotal Research Programs of Classical Physics”**(in English; Minkowski Institute Press, Montreal, Canada, 2020. - 259p.)

Thanks to Google Scholar, Nugayev’s **h-index** is 21, while his $i_{10} = 26$. According to *Scopus*, *Web of Science*, and *Semantic Scholar* Nugayev’s h-index is equal to 4 ,5, and 5, respectively. More than 50 Nugayev’s papers and monographs are published in the journals indexed by SCOPUS and WoS.

