FINAL MEDIATED REPORT

AI Detection Report for Scientific excellence of the researchers - BT1: Th...

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Summary

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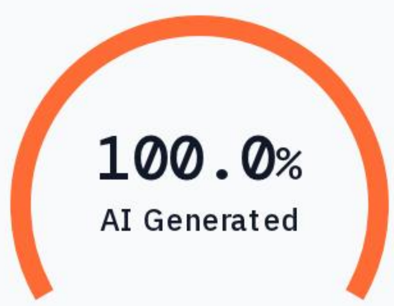

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Scientific excellence of the researchers - BT1: The project leader, Oleksiy Kostenko, demonstrates scientific excellence at the highest level, with a recognized leadership role in spectral graph theory and analysis on metric graphs, including non-compact settings that remain comparatively less explored in the current literature. His publication record in very selective venues (Inventiones Mathematicae, Proceedings of the London Mathematical Society, Advances in Mathematics, Journal of Functional Analysis, among others) attests to sustained, high-impact contributions and positions him among the foremost researchers in the field. The PI's recognition through prizes, invitations to high-profile conferences (e.g., 8ECM), and co-organization of international meetings with renowned speakers further underscores his standing and influence in shaping research directions. The proposal sets out a rich and ambitious program focused on differential operators on metric graphs—prominently Kirchhoff Laplacians—and the analytical/spectral phenomena that emerge in non-compact or otherwise structurally intricate graph topologies. These objectives align closely with the PI's recent advances, ensuring methodological continuity and increasing feasibility for significant new results. The plan to address less studied regimes in spectral graph theory (non-compact graphs, distribution of eigenvalues and trace formulas, boundary phenomena, functional calculus, p-ellipticity, bilinear estimates) is well chosen and reflects a deep understanding of the terrain and its open problems. In particular, the targeted blend of spectral analysis, operator theory, and refined functional tools promises

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contributions of genuine conceptual originality rather than incremental improvements. Independent and creative thinking is evident both from the PI's prior work—where novel approaches have yielded results in challenging contexts —and from the proposal's focus on uncovering new aspects of graph analysis through original methodologies tailored to metric and Cayley graph structures. The program's scope and technical depth point to a PI capable of formulating compelling problems, selecting the right analytical frameworks, and driving discovery at the frontier. Reviewer-cited recent works provide concrete evidence that the PI's ideas are not merely prospective but are already bearing fruit in closely connected domains, which bodes well for the proposed extensions. The ability to prepare a research proposal and conduct research is convincingly demonstrated.

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The application is well organized, with clear objectives, a logical structure, and a detailed execution plan that maps tasks to outcomes and integrates the expertise of a strong and experienced team. Leadership assignments and collaboration patterns appear coherent and leverage complementary strengths across spectral graph theory, Laplacian analysis, and functional analytic techniques. The PI's prior success in project management and coordination, combined with the team's collaborative experience, supports confidence in timely delivery of milestones and dissemination of results. Overall, the PI's outstanding achievements, his demonstrated independence and creativity, and the clear, feasible plan for a technically ambitious set of problems provides compelling evidence that the project will advance the analysis of graphs and networks in substantive and original ways. Scientific excellence of application - BT2: The application addresses important and timely research challenges in spectral graph theory and analysis on metric graphs, with particular emphasis on non-compact settings where the current literature is comparatively sparse. The presentation of research problems is well grounded in a furnished state of the art: core goals include rigorous treatment of self-adjointness, spectral properties, and boundary conditions for operators such as the Kirchhoff Laplacian (and its Sturm–Liouville variants), Schrödinger operators, and, more generally, classes generated by semigroups on metric graphs—both compact and non-compact. These targets are challenging in a competitive area and, by focusing on regimes and operator frameworks that have not yet been thoroughly analyzed, the proposal positions itself to close relevant gaps. The project aims to introduce new analytical methods and perspectives for metric and Cayley graph settings, extending semigroup and functional calculus techniques to non-compact geometries, and developing refined tools for eigenvalue distribution, trace formulas, p-ellipticity, and bilinear estimates. This is not merely incremental: pushing semigroup properties, boundary analysis, and spectral regularity into less-studied non-compact contexts requires conceptual innovation and technical depth.

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The density of the proposal reflects the breadth of its objectives, and while the level of ambition is high, the alignment with recent advances in the field suggests plausible pathways to

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results that would substantially impact spectral graph theory and related domains. The concept is sound and coherently structured around operator-theoretic and spectral frameworks that naturally connect across objectives. The focus remains appropriately in pure mathematics, yet the relevance extends beyond theory: spectral features of networked dynamics emerge as natural applications, and advances in boundary conditions and spectral distribution on graphs can provide modeling choices in complex networks. The project is highly original. The planned extension of analytical properties of semigroups to non-compact graph situations, the systematic treatment of self-adjointness and boundary conditions for metric-graph operators, and the unification of spectral tools (e.g., trace formulas, functional calculus) across operator families reflect a distinctive program that aims at new results rather than routine generalizations. The deliberate focus on non-compact settings—which are underexplored yet central to realistic graph models—underscores creative problem selection and a willingness to engage with technically demanding frontiers. Regarding methodology adequacy, the proposal sets out a convincing rodamap, including semigroup methods, functional calculus, operator boundary theory, and spectral analysis—that are apt for the kinds of problems described. The detailed document offers “issues of investigation” and ideas to tackle mathematical obstacles in each thematic strand; even where per-objective methodological granularity is not exhaustively specified, the outlined approaches fit the goals and demonstrate awareness of the technical levers required (e.g., control of domains and boundary forms, spectral measure regularity, semigroup kernel estimates, and stability properties in non-compact geometries). This balance between high-level design and targeted technical tools supports feasibility, and the close connection to the PI’s recent results increases confidence that the methods are both realistic and potent.

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In sum, the application successfully addresses important research challenges with ambitious and original objectives. Its concept is coherent and relevant, rooted in operator and spectral analysis on graphs with a distinctive emphasis on non-compact regimes. The methodology—though not exhaustively detailed per objective—appears appropriate and sufficiently developed to achieve the stated goals, especially given the PI’s track record and the project’s focus on well-identified gaps. Quality and efficiency of the implementation - BT3: The work plan is broadly effective and credible. The proposal precisely describes the principal research topics and outlines ideas for tackling core mathematical issues across spectral graph theory, operator theory, complex/hyperbolic geometry, and analysis on metric/Cayley graphs. The team is strong and diverse, with complementary skills that make the group strategy reliable; several members have already collaborated fruitfully on related topics with joint publications, which supports execution feasibility and integration across strands. In line with this, the overall schedule and sequencing of activities appear sensible, and the budget allocation—prioritizing mobility, conference organization, workshops, summer schools, and dissemination—looks convincing and aligned with the project’s ambitions. The plan to establish an internal seminar with a dedicated platform is a good mechanism for coordination, diffusion of knowledge, and sustained momentum. To further strengthen implementation clarity, the description of sub-teams per research objective should be presented more deeply, with explicit task ownership and role delineation. The current listing of part-time contributions for collaborators could be explained

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better, particularly for those already engaged in other projects; providing brief justifications of effort allocation, load balancing, and potential overlap management would improve transparency. Resource planning and risk management are, on the whole, adequate and supportive of the proposed scientific approach. The budget is coherently tied to collaborative activities and community engagement, which are essential for a project at this level. Building on that, the management plan could make risk handling more explicit by identifying concrete technical or coordination risks (e.g., delays in foundational proofs for non-compact settings, competing commitments among key personnel, or scheduling dependencies around major events) and by associating each with contingency actions, decision points, and fallback routes.

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Even brief per-objective risk notes—linked to the internal seminar cadence and milestone checkpoints—would make the plan more robust. Importantly, the scientific approach itself is feasible and well matched to the project's goals: extending analytical properties of semigroups to non-compact graph situations, refining boundary/self-adjointness frameworks for metric-graph operators, and unifying spectral tools across operator families are tasks squarely within the team's expertise. The prior collaborative experience and existing publication record provide confidence that the methods—semigroup techniques, spectral/functional analysis, and operator boundary theory—can be advanced in a disciplined, measurable way. With clearer sub-team structures, annotated scheduling, and brief effort rationales, the implementation will be fully commensurate with the project's ambition. Overall, the work plan is effective, the allocation of resources and roles is generally adequate, and the scientific approach is feasible.