Report of the RCNP Collaboration Research Network (RCNP-COREnet)

COREnet049 PI: FUJII Daisuke

1	Title of research		Investigation of the relation between hadron's stability and stress distribution from gravitational form factors
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3	Period of research		2024.4~2025.3
4	Main location of collaboration implementation		RCNP (Osaka U.), ASRC (JAEA), YITP (Kyoto U.), Nagoya U.
5	Publication list (Please include DOI if available)	Articles	D. Fujii, K. Nakayama, K. Suzuki, "Dual chiral density wave induced oscillating Casimir effect", Phys. Rev. D 110, 014039 (2024).
			D. Fujii, A. Iwanaka, M. Kitazawa, D. Suenaga, "Novel first-order phase transition and critical points in SU(3) Yang-Mills theory with spatial compactification", Phys. Rev. D 110, 094016 (2024).
			D. Fujii, A. Iwanaka, M. Tanaka, "Gravitational form factors of pion from top-down holographic QCD", Phys. Rev. D 110, L091501 (2024).
			D. Fujii, K. Nakayama, K. Suzuki, "Casimir effect on the lattice spacetime", Int. J. Mod. Phys. A 40, 10n11, 2543017 (2025)
			D. Fujii, K. Nakayama, K. Suzuki, "Casimir effect at finite density", Int. J. Mod. Phys. A 40, 10n11, 2543020 (2025)
			D. Fujii, K. Nakayama, K. Suzuki, "Casimir effect in dual chiral density waves", Int. J. Mod. Phys. A 40, 10n11, 2543022 (2025)
			D. Fujii, M. Kawaguchi, M. Tanaka, "Dominance of gluonic scale anomaly in confining pressure inside nucleon and D-term", Accepted for publication in Phys. Lett. B (2025).
		Talks	"Gravitational form factors of pion in the top-down holographic QCD approach", D. Fujii, A. Iwanaka, M. Tanaka, THE COMPUTER SCIENCE AND GRAVITATION CONFERENCE, 19-23 August 2024, Kahazar University (Neftchilar Campus), Baku, Azerbaijan (online talk).
			"Anisotropic pressure and novel first-order phase transition in SU(3) Yang-Mills theory on T2 ×R2 , D. Fujii, A. Iwanaka, M. Kitazawa, D. Suenaga, XVIth Quark Confinement and the Hadron Spectrum Conference, 19-24 August 2024, Cairns Convention Centre, Cairns,
			"Casimir effect in magnetized dense QCD", D. Fujii, K. Nakayama, K. Suzuki, XIII International Conference on New Frontiers in Physics, 26 Aug-4 Sep 2024, OAC, Kolymbari, Crete, Greece.
			"Casimir effect in dual chiral density waves", D. Fujii, K. Nakayama, K. Suzuki, FIFTH INTERNATIONAL SYMPOSIUM ON THE CASIMIR EFFECT, 15-21 September 2024, Pastoral Cultural Center Georgios, Piran, Slovenia.

		Talks	“Dual chiral density wave 相におけるカシミア効果” , 第 79 回京都ミーティング, 2024 年 12 月 14-15 日, JAEA TOLAI MIRAI BASE, 東海村.
			”スケール-カイラル有効模型による核子の重力形状因子”, 藤井大輔, 川口眞実也, 田中満, 日本物理学会 2025 春季大会, オンライン開催.
			”有限密度フェルミオニックカシミア効果に対するリフシッツ公式 , 藤井大輔, 中山勝政, 鈴 木渓, 日本物理学会 2025 春季大会, オンライン開催.
			“Gravitational form factors of the nucleon from the chiral effective model”, D. Fujii, A. Iwanaka, M. Tanaka, The 21st International Conference on Hadron Spectroscopy and Structure, 27-31 March 2025, Osaka University (Toyonaka Campus), Osaka, Japan.
6	Description of the results and outputs		This project aimed to uncover the mechanism behind the existence of hadrons by investigating the origin of internal forces such as pressure and shear force. With recent experimental determinations of the proton's internal stress and the upcoming EIC project emphasizing hadron structure, theoretical understanding is urgently needed. In FY2024, we made progress through the following four collaborative efforts: 1. Origin of the confining pressure inside the proton 2. Formulation of pion gravitational form factors and stress distributions in top-down holographic QCD 3. Quark-induced pressure (Casimir effect) in finite-volume systems 4. Gluon-induced thermodynamic pressure under finite-volume and finite-temperature conditions All results have been published and presented at multiple academic venues, including international conferences. Notably, we clarified that the gluonic scale anomaly is the main source of the confining pressure in the proton, representing a major step toward understanding hadron structure. This project also strengthened our research network through in-person meetings and broader collaboration, including with experimentalists.
7	Amount of budget implemented (for internal use only)		458230 JPY