

1	Title of research	"Tensor and quark dynamics in the Pc and X(3872)"	
2	List of Participants (Name and affiliation)	Yasuhiro Yamaguchi, Advanced Science Research Center, Japan Atomic Energy Agency	
		Sachiko Takeuchi, Japan College of Social Work	
		Elena Santopinto, National Institute for Nuclear Physics (INFN), Genoa	
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Makoto Takizawa, Showa Pharmaceutical University			
3	Period of research	From June 2020 to March 2022	
4	Main location of collaboration implementation	RCNP, Osaka University and KEK Tokai Campus	
5	Publication list (Please include DOI if available)	Articles	Strange pentaquarks with a hidden heavy quark-antiquark pair , S. Takeuchi, A. Giachino, M. Takizawa, E. Santopinto and M. Oka , Proceedings of the 18th International Conference on Hadron Spectroscopy and Structure https://doi.org/10.1142/9789811219313_0056
		Talks	クォーク状態との結合を伴うハドロン分子としての Pcペンタクォーク状態 山口康宏, 保坂淳, 竹内幸子, 瀧澤誠 日本物理学会 2020年秋季大会
			X(3872): cbar \bar{c} が存在する2メソン散乱系と共鳴極に関する研究 竹内幸子, 瀧澤誠, 山口康宏, 保坂淳 日本物理学会 2020年秋季大会
			Heavy baryons A. Hosaka SnowMass21
			Quark color degrees of freedom in multi-quark exotics: Pentaquarks [uudQ \bar{Q} , udsQ \bar{Q}] S. Takeuchi, H. G.-Tecocoatz, A. Giachino, M. Takizawa, E. Santopinto and M. Oka, Workshop on Clustering as a window on the hierarchical structure of quantum systems
			Pcペンタクォーク状態におけるパイオン交換力とコンバクト状態への結合 山口康宏 ELPH 研究会 C029「様々なフレーバー領域で探るクォーク・ハドロン多体系の分光と構造」
			Heavy baryon Spectroscopy A. Hosaka APCTP-KPS-JPS meeting
			ハドロン物理入門 瀧澤誠 Flavor Physics Workshop 2020
			Hidden charm pentaquarks with chiral tensor and quark dynamics Y. Yamaguchi Physics of heavy-quark and exotic hadrons 2021
			Pole position of X(3872) in the charmonium hadronic-molecule hybrid approach S. Takeuchi Physics of heavy-quark and exotic hadrons 2021
			Heavy hadronic molecules coupled with multi-quark states Y. Yamaguchi The 8th Asia-Pacific Conference on Few-Body Problems in Physics
			X(3872) revisited: the roles of OPEP and the quark degrees of freedom S. Takeuchi, Y. Yamaguchi, A. Hosaka, M. Takizawa The 8th Asia-Pacific Conference on Few-Body Problems in Physics
			Strange pentaquark resonances with a heavy quark antiquark pair [udsQ \bar{Q}] S. Takeuchi, A. Giachino, M. Takizawa, E. Santopinto and M. Oka The 8th Asia-Pacific Conference on Few-Body Problems in Physics
			Heavy hadronic molecules with pion exchange and coupling to multi-quarks Y. Yamaguchi Hadron in Nucleus 2020
			ハドロン動力学によるPcペンタクォークの質量スペクトル 山口康宏 日本物理学会 第76回年次大会
			Strange hidden-charm ペンタクォークにおけるメソン交換力と5クォーク状態への結合 山口康宏, 保坂淳, 竹内幸子, 瀧澤誠 日本物理学会 第76回年次大会
重いクォーク対を含むペンタクォークの崩壊の研究 竹内幸子, 瀧澤誠, 山口康宏, 保坂淳 日本物理学会 第76回年次大会			
X(3872) in the hybrid model of charmonium and hadronic molecule Y. Yamaguchi, S. Takeuchi, M. Takizawa, A. Hosaka Experimental and theoretical status of and perspectives for XYZ states			
Theses			
6	Description of the results and outputs	<p>We have extended our study of hidden charm pentaquark states, the uud c\bar{c}bar system (Phys. Rev. D 101, 091502(R) (2020)) to uds cc bar systems. We have obtained resonances which should be observed in the LHCb experiment. Recently, LHCb reported the evidence of such a resonance.</p> <p>We have studied the X(3872) state in the meson molecule with a charmonium core coupling. OPEP has been introduced to the meson molecules. We have calculated the X(3872) to D D* bar, J/psi rho and J/psi omega decay spectra in the case of the X(3872) produced in the B decay. The pole position of X(3872) has been carefully studied in the complex scaling method and compared with LHCb result. Our result is consistent with LHCb result.</p> <p>We have reported our results in conferences and workshops. We are now preparing journal papers.</p> <p>The discussion meetings were held about 20 times in the period of research by using Zoom system provided by COREnet.</p> <p>A. Hosaka and M. Takizawa organized the workshop on "Physics of heavy-quark and exotic hadrons 2021" at KEK Tokai campus in Feb. 2021. We were able to gather in the same place and have intensive discussions on physics. We also invited an Italian member, Elena Santopinto, to this workshop for discussion.</p>	