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Refereed Journal Papers

[m-honma-01:2012] B. Alex Brown Michio Honma Takahiro Mizusaki Yutaka Utsuno, Takaharu Otsuka and Noritaka Shimizu. Shape transitions in exotic Si and S isotopes and tensor-force-driven Jahn-Teller effect. *Phys. Rev. C*, 86:051301(R)/1–6, 2012.

We show how shape transitions in the neutron-rich exotic Si and S isotopes occur in terms of shell-model calculations with a newly constructed Hamiltonian based on VMU interaction. We first compare the calculated spectroscopic-strength distributions for the proton $0d_{5/2,3/2}$ and $1s_{1/2}$ orbitals with results extracted from a ^{48}Ca(e,e$'$ p) experiment to show the importance of the tensor-force component of the Hamiltonian. Detailed calculations for the excitation energies, B(E2), and two-neutron separation energies for the Si and S isotopes show excellent agreement with experimental data. The potential-energy surface exhibits rapid shape transitions along the isotopic chains towards N=28 that are different for Si and S. We explain the results in terms of an intuitive picture by involving a Jahn-Teller-type effect that is sensitive to the tensor-force-driven shell evolution. The closed subshell nucleus ^{42}Si is a particularly good example of how the tensor-force-driven Jahn-Teller mechanism leads to a strong oblate rather than a spherical shape.

[m-honma-02:2012] S. J. Freeman M. P. Carpenter P. Chowdhury A. N. Deacon M. Honma H. Jin T. Lauritsen C. J. Lister J. Meng J. Peng D. Seweryniak J. F. Smith Y. Sun S. L. Tabor B. J. Varley Y.-C. Yang S. Q. Zhang P. W. Zhao D. Steppenbeck, R. V. F. Janssens and S. Zhu. Magnetic rotation and quasicollective structures in ^{58}Fe: Influence of the $\nu g_{9/2}$ orbital. *Phys. Rev. C*, 85:044316/1–23, 2012.

The structure of ^{58}Fe was investigated at Gammasphere using ^{48}Ca(^{13,14}C,xn) fusion-evaporation reactions at a beam energy of 130 MeV. The level scheme has been revised and extended to $J \sim 17\hbar$ and an excitation energy of 16.6 MeV. Regular band structures consisting of low-energy ΔJ=1$\hbar$ transitions have been observed at moderate spin ($J \sim 8\hbar - 15\hbar$) and are candidates for magnetic rotational bands. Self-consistent tilted-axis-cranking calculations within a relativistic mean-field theory were applied to investigate these bands and were found to reproduce the experimental results well. In other parts of the level scheme, quasirotational bands composed of stretched-E2 transitions have been extended to high spin, and other new

bands have been identified. Positive-parity experimental states were compared to predictions of the spherical shell model using the GXPF1A, KB3G, and FPD6 effective interactions in the fp model space. The projected shell model, with a deformed quasiparticle basis including the neutron $\nu g_{9/2}$ orbital, was applied to interpret regular $\Delta J{=}2\hbar$ band structures that extend beyond the maximum spin available for $\pi[(f_{7/2})^{-2}] \otimes \nu[(p_{3/2} f_{5/2} p_{1/2})^4]$ configurations and exhibit features characteristic of rotational alignment. It is clear that the $\nu g_{9/2}$ intruder orbital plays a crucial role in describing the quasirotational structures in this nucleus, even starting as low as $J \sim 5\hbar$.

[m-honma-03:2012] Toshio Suzuki and Michio Honma. Neutrino capture reactions on ^{40}Ar. *Phys. Rev. C*, 87:014607/1–4, 2013.

Gamow-Teller (GT) strength in ^{40}Ar is studied by shell-model calculations with monopole-based universal interaction, which has tensor components of $\pi + \rho$-meson exchanges. Calculated GT strength is found to be consistent with the experimental data obtained by recent (p,n) reactions. Neutrino capture cross sections on ^{40}Ar for solar neutrinos from ^{8}B are found to be enhanced compared with previous calculations. The reaction cross sections for multipoles other than 0^+ and 1^+ are obtained by random-phase approximation (RPA). Their contributions become important for neutrino energies larger than 50 MeV.

[m-honma-04:2012] R. G. T. Zege Sam M. Aust D. Bazin B. A. Brown C. Caesar A. L. Cole J. M. Deaven N. Ferrante C. J. Guess G. W. Hitt M. Honma R. Meharchand F. Mont J. Palardy A. Prinke L. A. Riley H. Sakai M. Scott A. Stolz T. Suzuki L. Valdez M. Sasano, G. Perdikakis and K. Yako. Extraction of Gamow-Teller strength distributions from ^{56}Ni and ^{55}Co via the (p, n) reaction in inverse kinematics. *Phys. Rev. C*, 86:034324/1–13, 2012.

A new technique for measuring (p, n) charge-exchange reactions on unstable nuclei was successfully developed. It can be used to study the isovector response of unstable nuclei in any mass region and for excitation energies beyond the particle decay threshold. In the first experiment, ^{56}Ni(p, n) and ^{55}Co(p, n) reactions were studied and GT transition strengths were extracted for the purpose of testing shell-model calculations used to estimate electron-capture rates in simulations of late stellar evolution. The calculation using the GXPF1J interaction was found to best reproduce the experimental strength distribution.

[m-honma-05:2012] H. Ohgaki H. Toyokawa T. Komatsubara N. Kikuzawa T. Inakura M. Honma T. Shizuma, T. Hayakawa and H. Nakada. Dipole strength distribution in ^{56}Fe. *Phys. Rev. C*, 87:024301/1–7, 2013.

Electromagnetic dipole transitions in ^{56}Fe were measured in photon-scattering experiments with a linearly polarized photon beam. The parity quantum numbers of the excited dipole states were determined by the intensity asymmetry of resonantly scattered γ rays with respect to the polarization plane of the incident photon beam. While the summed magnetic dipole (M1) strength was determined as $\sum B(\mathrm{M1})\uparrow$=3.52(17) μ_N^2 at excitation energies between 7 and 10 MeV, the summed electric dipole (E1) strength below 10 MeV was obtained as $\sum B(\mathrm{E1})\uparrow$=78.0(15)$\times 10^{-3}$ e^{2}fm^2. The observed M1 strength was compared with shell-model predictions in the pf shell using the GXPF1J and KB3G effective interactions. In addition, the E1 strength was compared with random-phase approximation calculations with the Skyrme interaction.

[m-honma-06:2012] Shoji Nakamura Michio Honma Futoshi Minato Takehito Hayakawa Kaoru Y. Hara Atsushi Kimura Mitsuo Koizumi Hideo Harada Jun Goto Masumi Oshima, Tadahiro Kin and Yukihiro Murakami. Spectroscopic Study of ^{63}Ni via Cold Neutron Capture Reaction: I. Nuclear Structure of ^{63}Ni. *J. Phys. Soc. Jpn.*, 81:084201/1–15, 2012.

The γ-radiation has been investigated for ^{63}Ni produced by cold neutron capture in an enriched ^{62}Ni sample. The 315 γ-rays produced were placed in a ^{63}Ni level scheme, in which 272 placements are new. We determined the excitation energies with 0.2-0.8 keV error and the branching ratios of 62 bound levels in ^{63}Ni, including 30 new levels. The Q-value of the ^{62}Ni(n,γ)^{63}Ni reaction amounts to 6837.75$\pm$0.18 keV. A large-scale shell-model calculation was performed that included the four single-particle orbits of $0f_{7/2}$, $1p_{3/2}$, $0f_{5/2}$, and $1p_{1/2}$, assuming an inert ^{40}Ca core for negative-parity states, and those of $1p_{3/2}$, $0f_{5/2}$, $1p_{1/2}$, and $0g_{9/2}$, assuming a ^{56}Ni core for positive-parity states. The energies of the low-lying ^{63}Ni states were successfully reproduced. A mean-field statistical-model calculation was also performed by using a self-consistent interaction between the Hartree-Fock + Bardeen-Cooper-Schrieffer method and the statistical calculation. The calculation result is consistent with the experimental level density of ^{63}Ni.

[m-honma-07:2012] Takahiro Mizusaki Michio Honma Yusuke Tsunoda Noritaka Shimizu, Yutaka Utsuno and Takaharu Otsuka. Variational

procedure for nuclear shell-model calculations and energy-variance extrapolation. *Phys. Rev. C*, 85:054301/1–6, 2012.

We discuss a variational calculation for nuclear shell-model calculations and propose a new procedure for the energy-variance extrapolation (EVE) method using a sequence of the approximated wave functions obtained by the variational calculation. The wave functions are described as linear combinations of the parity, angular-momentum projected Slater determinants, the energy of which is minimized by the conjugate gradient method obeying the variational principle. The EVE generally works well using the wave functions, but we found some difficult cases where the EVE gives a poor estimation. We discuss the origin of the poor estimation concerning shape coexistence. We found that the appropriate reordering of the Slater determinants allows us to overcome this difficulty and to reduce the uncertainty of the extrapolation.

[m-honma-08:2012] Y. Fujita T. Adachi A. Algora M. Csatlós J. M. Deaven E. Estevez-Aguado C. J. Guess J. Gulyás K. Hatanaka K. Hirota M. Honma D. Ishikawa A. Krasznahorkay H. Matsubara R. Meharchand F. Molina H. Okamura H. J. Ong T. Otsuka G. Perdikakis B. Rubio C. Scholl Y. Shimbara G. Susoy T. Suzuki A. Tamii J. H. Thies R. G. T. Zegers E. Ganioğlu, H. Fujita and J. Zenihiro. High-resolution study of Gamow-Teller transitions in the ^{47}Ti(^{3}He,t)^{47}V reaction. *Phys. Rev. C*, 87:014321/1–12, 2013.

Given the importance of Gamow-Teller (GT) transitions in nuclear structure and astrophysical nuclear processes, we have studied $T_z = +3/2 \rightarrow +1/2$, GT transitions starting from the ^{47}Ti nucleus in the (^{3}He,t) charge-exchange reaction at 0° and at an intermediate incident energy of 140 MeV/nucleon. The experiments were carried out at the Research Center for Nuclear Physics (RCNP), Osaka, using the high-resolution facility with a high-dispersion beam line and the Grand-Raiden spectrometer. With an energy resolution of 20 keV, individual GT transitions were observed and GT strength was derived for each state populated up to an excitation energy (E_x) of 12.5 MeV. The GT strength was widely distributed from low excitation energy up to 12.5 MeV, where we had to stop the analysis because of the high level density. The distribution of the GT strengths was compared with the results of shell model calculations using the GXPF1 interaction. The calculations could reproduce the experimental GT distributions well. The GT transitions from the ground state of ^{47}Ti and the M1 transitions from the isobaric analog

state in ^{47}V to the same low-lying states in ^{47}V are analogous. It was found that the ratios of GT transition strengths to the ground state, the 0.088-MeV state, and the 0.146-MeV state are similar to the ratios of the strengths of the analogous M1 transitions from the isobaric analog state (IAS) to these states. The measured distribution of the GT strengths was also compared with those starting from the $T_z = +3/2$ nucleus ^{41}K to the $T_z = +1/2$ nucleus ^{41}Ca.

[m-honma-09:2012] Yusuke Tsunoda Yutaka Utsuno Tooru Yoshida Takahiro Mizusaki Michio Honma Noritaka Shimizu, Takashi Abe and Takaharu Otsuka. New-generation Monte Carlo shell model for the K computer era. *Prog. Theor. Exp. Phys.*, 2012:01A205/1–27, 2012.

We present a newly enhanced version of the Monte Carlo shell-model (MCSM) method by incorporating the conjugate gradient method and energy-variance extrapolation. This new method enables us to perform large-scale shell-model calculations that the direct diagonalization method cannot reach. This new-generation framework of the MCSM provides us with a powerful tool to perform very advanced large-scale shell-model calculations on current massively parallel computers such as the K computer. We discuss the validity of this method in ab initio calculations of light nuclei, and propose a new method to describe the intrinsic wave function in terms of the shell-model picture. We also apply this new MCSM to the study of neutron-rich Cr and Ni isotopes using conventional shell-model calculations with an inert ^{40}Ca core and discuss how the magicity of N=28,40,50 remains or is broken.

[m-honma-10:2012] B. P. Kay J. A. Clark C. M. Deibel S. J. Freeman M. Honma A. M. Howard A. J. Mitchell T. Otsuka P. D. Parker D. K. Sharp J. P. Schiffer1, C. R. Hoffman and J. S. Thomas. Valence nucleon populations in the Ni isotopes. *Phys. Rev. C*, 87:034306/1–15, 2013.

Measurements of neutron-adding, neutron-removing, and proton-adding reactions were carried out for the four stable even Ni isotopes. Particular attention was paid to obtaining precise values of the cross sections at the peaks of the angular distributions. Tests with sum rules for the neutron data indicate that the results are self-consistent at the level of a few tenths of a nucleon. Data on proton-adding reactions were also obtained and analyzed with a slightly different method—while these data are also consistent, the ambiguities are larger. The occupancies of the neutron orbits derived from the data, the proton vacancies, and the energy centroids of the neutron,

neutron-hole, and proton single-particle excitations are obtained. The data also provide some estimate about the closure of the $0f_{7/2}$ shell. The results are compared to shell-model calculations and may serve as a reference point for future exploration.

[t-maeda-01:2012] Takao MAEDA and Takafumi HAYASHI. Parameterization of Perfect Sequences over a Composition Algebra. *IEICE TRANSACTIONS on Fundamentals of Electronics, Communications and Computer Sciences*, Vol. E95-A(No. 12):2139 – 2147, December 2012.

A parameterization of perfect sequences over composition algebras over the real number field is presented. According to the proposed parameterization theorem, a perfect sequence can be represented as a sum of trigonometric functions and points on a unit sphere of the algebra. Because of the non-commutativity of the multiplication, there are two definitions of perfect sequences, but the equivalence of the definitions is easily shown using the theorem. A composition sequence of sequences is introduced. Despite the non-associativity, the proposed theorem reveals that the composition sequence from perfect sequences is perfect.

[t-watanb-01:2012] T. Watanabe and K. Yamamuro. Tail behaviors of semi-stable distributions. *J. Math. Anal. Appl.*, 393(1):108–121, 2012.

Asymptotic behaviors of tails of semi-stable distributions on the line are analyzed. Two sharp upper and lower estimates of their tails are given by using the tails of their Lvy measures and the power functions with the proper exponents. In the case where their Lvy measures vanish on the half line, the exact decay orders of the logarithms of their tails are discussed.

[tsuchiya-01:2012] Hiroya Hashimoto and Takahiro Tsuchiya. Remarks on the rate of strong convergence of Euler-Maruyama approximation for SDEs driven by rotation invariant stable processes. *JSIAM Letters*, 5:13–16, 2013.

In this paper, we consider Euler-Maruyama approximations for 1-dimensional stochastic differential equations (SDEs) driven by rotation invariant (i.e. symmetric) α stable processes and discuss their rate of strong convergence by numerical simulations. We also study the relationship between the convergence rate and the index α of rotation invariant stable process and/or the exponent γ of the Hlder continuity of the diffusion coefficient.

[yamagami-01:2012] M. Yamagami, J. Margueron, H. Sagawa, and K. Hagino. Isoscalar and isovector density dependence of the pairing functional determined from global fitting. *Phys. Rev. C86*, page 034333, 2012.

We optimize the density dependence of a local energy density functional for pairing correlations (pair-DF) taking into account both the isoscalar and the isovector densities. The new pair-DFs give the best fit for all the pairing gaps with the r.m.s. deviation of σ_{tot}=(260∼360) keV depending on adopted Skyrme interactions in the particle-hole channel. We also discuss the predictive power for pairing properties in nuclei with large neutron excess around the neutron drip line.

[yamagami-02:2012] M. Yamagami, J. Margueron, H. Sagawa, and K. Hagino. Local energy density functional for proton pairing correlations. *RIKEN Accel. Prog. Rep. 45*, page 40, 2012.

We investigated the effect of Coulomb force in proton pairing correlation within the framework of the local energy density functional (EDF). By taking into account the reduction effect for proton pairing correlation, we proposed two renormalization schemes; 1) reduction of proton pairing strength, and/or 2) scaling of the linear isovector-density dependence in the pairing channel of EDF. We examined the accuracy of the renormalization schemes by analyzing all available experimental pairing gaps.

[yamagami-03:2012] M. Yamagami, J. Margueron, H. Sagawa, and K. Hagino. Development of local energy density functional for description of pairing correlations in drip-line regiong. *RIKEN Accel. Prog. Rep. 46*, page in press, 2013.

We discuss the predictive power of our local energy density functional for pairing correlations in nuclei around the neutron drip line. An empirical relation among the parameters in the isoscalar part of pair-DF is extracted. The uncertainty of the isovector part is also examined by calculating the pairing gaps of neutron-rich and proton-rich nuclei in a wider region of of the nuclear chart.

Unrefereed Papers

[k-asai-01:2012] Kazuto Asai. The group generated by gamma functions $\Gamma(ax+1)$, and its subgroup of the elements converging to constants. *mathematics e-print arXiv*, arXiv:1304.6234:1–8, 3–4 (posted) 2013.

[kihara-01:2012] HIROSHI KIHARA. COGROUPS IN THE CATEGORY OF CONNECTED GRADED ALGEBRAS WHOSE INVERSE AND ANTIPODE COINCIDE. *Front for the Mathematics ArXiv*, March 2013.

Let A be a cogroup in the category of connected graded algebras over a commutative ring R. Let ν denote the inverse of A and χ the antipode of the underlying Hopf algebra of A. We clarify the differences and similarities of ν and χ, and show that ν coincides with χ if and only if A is commutative as a graded algebra. Let Aco be CG the category of cogroups satisfying these equivalent conditions. If R is a field, the category Aco is completely determined. We also establish CG an equivalence of the full subcategory of Aco consisting of objects of CG finite type with a full subcategory of the category of positively graded R-modules without any assumption on R. The results in the case of R = Q are applied to the theory of co-H-groups.

Refereed Proceeding Papers

[t-maeda-02:2012] Takafumi HAYASHI, Takao MAEDA, Shigeru KANEMOTO, and Satoshi OKAWA. A Novel Class of Zero-Correlation Zone Sequence Set having Sequence Subsets. In *Proceedings of IEEE VTS Asia Pcific Wireless Communications Symposium 2012*, page a4.1, August 2012.

The present paper introduces a new approach to the construction of a sequence set with a zero-correlation zone. The proposed sequences can be constructed from a Hadamard matrix of the order n. The constructed sequence set consists of 2n(2m − 1) ternary sequences, each of length (n+1)4m, for a non-negative integer m. The zero-correlation zone of the proposed sequences is $|\tau| \leq 2m$, where τ is the phase shift. The sequence member size of the proposed sequence set is equal to 2n(2m − 1). The proposed sequence set consists of (2m − 1) subsets, each of member size $2n$. The correlation function of the sequences of a pair of different subsets, referred to as the inter-subset correlation function, has a zero-correlation zone with a width that is approximately twice that of the correlation function of sequences of the same subset (intra-subset correlation function). This contributes to the performance improvement of applications of the proposed sequence set. The proposed sequence set has a zero-correlation zone for even and odd correlation functions. As such, the proposed sequence is suitable for an approximately synchronized code division multiple access (AS-CDMA) system. The wider inter-subset

zero-correlation can improve the application of the proposed sequence set to ultrasonic imaging and pulse radar systems.

[t-maeda-03:2012] Takao MAEDA and Takafumi HAYASHI. Fourier Analysis of Sequences over a Composition Algebra of the Real Number Field. In *Proceedings of 2012 International Symposium of Information Theory and its Applications (ISITA2012)*, pages 625–628, October 2012.

To analyze the structure of a set of perfect sequences over a composition algebra of the real number field, transforms of a set of sequences similar to DFT (discrete Fourier transform) are introduced. Discrete cosine transform, discrete sine transform and generalized discrete Fourier transform (GDFT) of the sequences are defined and the fundamental properties of these transforms are proved. We show that GDFT is bijective and that there exists a relationship between these transforms and a convolution of sequences. Applying these properties to the set of perfect sequences, a parameterization theorem of such sequences is obtained.

[t-maeda-04:2012] Takafumi HAYASHI, Shigeru KANEMOTO, and Takao MAEDA. Sequence Sets Having Wide Inter-Subset Zero-Correlation Zone and Its Applications to Instrumentation. In *Proceedings of Sice annual conference*, pages G1–305, 2012.

Sequences having good correlation properties are used in various applications, such as communication systems, radars, position detection, and ultrasonic imaging. A sequence set with the property whereby the out-of-phase autocorrelation and cross-correlation functions all vanish in a specified phase-shift zone is referred to as a ZCZ sequence set. In this paper, we presents a novel sequence construction of zerocorrelation zone (ZCZ) sequence set and its application of to the pulse compression of radars, ultrasonic imaging and wireless communications.

[tsuchiya-02:2012] Nobutaka Shimizu and Takahiro Tsuchiya. How does a Hot Spot come into existence? In *the Proceedings of SSS'12 (44th ISCIE International Symposium on Stochastic Systems Theory and Its Applications)*, page to be appear, 2013.

We point out that the SPEEDI failed to predict the south route which is proveded by the observed data and the hot spot because the equation of SPEEDI is lacking geographical information. Actually, we show that those can be predictable even by a very simple Markov chain model with transition probability based on geographical data.

Academic Activities

[sigeru-w-01:2012] S. Watanabe, 2012-2013.

Reviewer: Mathematical Reviews published by the American Mathematical Society

Ph.D and Others Theses

[a-fujitu-01:2012] Takahiro Nemoto. Master Thesis: Inflation of random lattice andvisualization., University of Aizu, 2013.

Thesis Advisor: A. Fujitsu

[a-fujitu-02:2012] Fumiya Kono. Master Thesis: Evolving Physics Simulations for Educationi and Estimating their Effectivity., University of Aizu, 2013.

Thesis Advisor: A. Fujitsu

[sigeru-w-02:2012] Kazushi Yanagisawa. Graduation thesis, School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[sigeru-w-03:2012] Genki Sato. Master thesis, Graduate School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[sigeru-w-04:2012] Erika Suzuki. Master thesis, Graduate School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[sigeru-w-05:2012] Daichi Kikuta. Graduation thesis, School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[sigeru-w-06:2012] Haruka Syoji. Graduation thesis, School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[sigeru-w-07:2012] Naoya Kumada. Graduation thesis, School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[sigeru-w-08:2012] Yosuke Kojima. Graduation thesis, School of Computer Science and Engineering, March 2012.

Thesis Adviser: S. Watanabe

[yamagami-04:2012] Masato Hashimoto. Graduation Thesis: Various theoretical considerations about expansions of the universe, School of Computer Science and Engineering, March 2012.

Thesis Advisor: M. Yamagami

[yamagami-05:2012] Shota Suzuki. Graduation Thesis: Simulation of wave motion with attenuation, School of Computer Science and Engineering, March 2012.

Thesis Advisor: M. Yamagami

[yamagami-06:2012] Seiji Yamamoto. Graduation Thesis: Selecting a well-balanced diet with web-based nearest neighbor search and a Bayesian network, School of Computer Science and Engineering, March 2012.

Thesis Advisor: M. Yamagami

[yamagami-07:2012] Naruki Shirai. Graduation Thesis: Calculation of the Velocity Potential of Stream, School of Computer Science and Engineering, March 2012.

Thesis Advisor: M. Yamagami

[yamagami-08:2012] Masayuki Nakata. Graduation Thesis: Judgment of necessity of nuclear power plants by the University of Aizu students, School of Computer Science and Engineering, March 2012.

Thesis Advisor: M. Yamagami

[tsuchiya-01:2012]Masato Hashimoto. Graduation Thesis: Various theoretical considerations about expansions of the universe, School of Computer Science and Engineering, March 2012.

Thesis Advisor: M.Yamagami.

Others

[k-asai-02:2012] Kazuto Asai. Split Chebyshev polynomials whose graphs are partially packed between two horizontal lines. preprint, 3 2013.

[k-asai-03:2012] Kazutro Asai. Handouts (Texts for classes) in Japanese: Discrete Systems (85 pages), Linear Algebra (84 pages), Complex Analysis (66 pages), Applied Algebra (47 pages). pdf-files, 2012 (revised edition).

http://web-ext.u-aizu.ac.jp/ k-asai/classes/class-texts.html