

Kunhao Zhong

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EDUCATION

- **Stony Brook University** Stony Brook, NY, USA
Master of Art - Physics; GPA: 3.96
Aug 2021 - present
Courses: String Theory, Particle Physics, Advanced Particle Physics, Computing Physics
- **University of Texas at Austin** Austin, TX, USA
Bachelor of Science - Physics; GPA: 3.91
Aug 2018 - May 2021
Graduate Level Courses: Quantum Field Theory (I&II), Electrodynamics, Statistical Mechanics, Cosmology, General Relativity, Quantum Mechanics, Astrophysics

RESEARCH EXPERIENCE

- **Master Thesis Research** Stony Brook, NY
Advisor: Vivian Miranda
May 2021 - present
 - **Geometry and Growth Split:** Splitting Geometry and Growth information to study the consistency between the expansion and structure growth of the universe.
 - **Anisotropic Stress of Dark Energy (Collaborative):** Study the Anisotropic Stress of Dark Energy using Parameterized Post-Friedmann prescription.
 - **Non-canonical Scalar Field of Dark Energy:** Generalisation of canonical Scalar Field (*Quintessence*) description of scalar field to non-canonical case.
- **UT Cosmology Group & Weinberg Theory Group** Austin, TX
Advisor: Kimberly Boddy
Aug 2020 - Aug 2021
 - **Enerly Dark Energy with ACT:** Using Atacama Cosmology Telescope (ACT) likelihood to test the discrepancy of primordial amplitude A_s between CMB and EFT of LSS.
 - **Migdal Effect around Recombination:** Study the secondary contribution of Dark Matter (DM)-baryon scattering from Migdal Effect, and its correction to CMB
- **Independent Study Program** Austin, TX
Advisor: Richard Matzner
Aug 2018 - Aug 2020
 - **Glory Scattering of Scalar Field wave to Balck Hole:** Generalized the cross section of scalar wave on a Schwarzschild black hole from flat space to conformal flat space, i.e, in a expanding universe.
 - **Independent study:** General Relativity and Cosmology: reading of *General Relativity* by Wald, and *Modern Cosmology* by Scott Dodelson.

PROGRAMMING SKILLS

- **CLASS-GSF in C:** A modified version of CLASS with non-canonical scalar field that the users can enter Lagrangians and initial conditions as needed, with several examples provided. The code will calculate both in background and perturbation level. Unlike *hi-class* that uses Effective Field Theory (EFT), the code uses full dynamical equations for scalar field. The code can be used to study dark energy clustering models like *k-essence*, as well as other component like generalized dark matter.
- **CAMB-AS in FORTRAN:** CAMB with anisotropic stress of dark energy, in PPF prescription. The equations implemented with full equations in PPF, and account for anisotropic stress contribution from photon, massless neutrino, and massive neutrino.
- **C++:** Implemented the Growth-Geometry splitting analysis routine into COCOA: The Cobaya-CosmoLike Joint Architecture. Added the Weyl potential power spectrum to the CosmoLike part so it can compute the effect of anisotropic stress of DE on weak lensing, with Intrinsic Alignment taking into account. This also enables the Modified Gravity study and other extension to be done in the Boltzman code, and thus enables cross analysis with CMB.
- **Parallel Computing:** MPI implementations on scripts that generate multiple cosmological observable from chains. The true posteriors of observable like power spectrum and distances are lack in most phenomenological study due to large number of chains. With Message-Passing Interface (MPI), this can be done within a reasonable time (1 hour for Λ CDM).
- **Mathematica:** Wrote a set of notebooks in calculating general relativity exercises. Experience in using cosmological perturbation package xPand to check the equations used in CLASS-gsf.
- **Machine Learning:** Currently learning on ML applications in cosmology, with focus on Normalizing Flow and Neural Network
- **Bash/Unix Environment:** Extensive experience in working on High Performance Computing Clusters. In UT-Austin, I wrote a sample for future students on how to use MontePython with Planck Likelihood. In Stony Brook University I helped other students in doing cosmological computing on clusters.

SURVEY MEMBERSHIP

- **Dark Energy Survey (DES):** Theory and Combined Probe working group
- **Rubin Observatory Legacy Survey of Space and Time (LSST):** Dark Energy Science Collaboration

PRESENTATIONS

- **DES 2022 Collaboration Meeting:** Growth and geometry split in light of DES data
- **Stony Brook Graduate Seminar Fall 2021:** Neutrino Cosmology

TEACHING & OUTREACH

- **Teaching Assistant** Stony Brook, NY
Instructor: Thomas Hemmick *Aug 2021 - present*
 - **PHY 134: Laboratory for Classical Physics (I & II):** Grade reports and help students finish their lab.
- **Undergrad Teaching Assistant** Austin, TX
Instructor: Sonia Paban, John Yeazell *Aug 2019 - May 2020*
 - **PHY 362K: Quantum Mechanics 2 :** Grade part of the homework and hold problem solving session.
 - **PHY302L: General Physics 2:** Attend normal Class session as learning assistant and hold office hours.

REFERENCES

- **Vivian Miranda** Stony Brook, NY, USA
C. N. Yang Institute for Theoretical Physics *vivian.miranda@stonybrook.edu*
- **Rogério Rosenfeld** São Paulo, Brazil
Universidade Estadual Paulista (UNESP) *rosenfel@ift.unesp.br*
- **Kimberly Boddy** Austin, Texas, USA
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