National Aeronautics and Space Administration

FY24 Topic Areas Research and Technology Development (TRTD)

Maximizing the Cosmological Synergies between SPHEREx and other Cosmological Surveys

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Strategic Focus Area: Origin, evolution, and structure of the universe

Objectives: Our long-term objective is to develop novel software tools that will allow the joint analysis of SPHEREx with other coming cosmological data set from the SPHEREx, Euclid, and Roman missions on the largest scales. The exact handling of the largest scales and the inclusion of partially correlated systematic effects are both important yet unsolved problems. We adapted our existing Spherical-Fourier Bessel (SFB) code to handle multiple surveys, including distinct and inhomogeneous selection functions. We developed it on simulations and applied it to mocks of the best publicly available dataset, i.e. distinct galaxy samples from eBOSS.

Background: SPHEREx will provide the first near-infrared all-sky spectral survey for the astronomical community and will create a data set of lasting legacy. SPHEREx probes primordial non-Gaussianity, and in particular the parameter fNL , using the power spectrum, that is the Fourier transforms of the 2-point galaxy correlation function. The effect of fNL is most prominent on the largest spatial scales and thus need an approach that enable optimal estimation of this parameter on the full (curved) sky over a large cosmological volume. When quantified with the Cartesian Fourier basis, the measurement of these large scales requires the introduction of so-called wide-angle corrections (e.g Beutler & Castorina 2019). By contrast, the measurement of the power spectrum in a SFB basis does not require such corrections and naturally accounts for the spherical survey geometries. In a series of papers, we developed, implemented, and thoroughly validated a set of code to measure accurate angular power spectra in SFB space (Gebhardt & Doré 2021a,b). We also developed and implemented a fast code to construct the SFB power spectrum and investigate how line of sight effects, physics such as non-Gaussianity, and differing survey geometries affect SFB power spectrum estimates (Khek, Gebhardt, Doré 2022).

Approach and Results: We extended our code to handle different galaxy samples with different selection functions, different weights, and partially overlapping footprints. We validated it and extended the covariance matrix for partially overlapping surveys. The local average effect, or integral constraint is handled differently than in the case of a single survey with a single tracer. We developed our own simulations using log-normal simulations and then compute exactly the correlated signal in the SFB basis. We applied this to simulations of SPHEREx and Euclid.

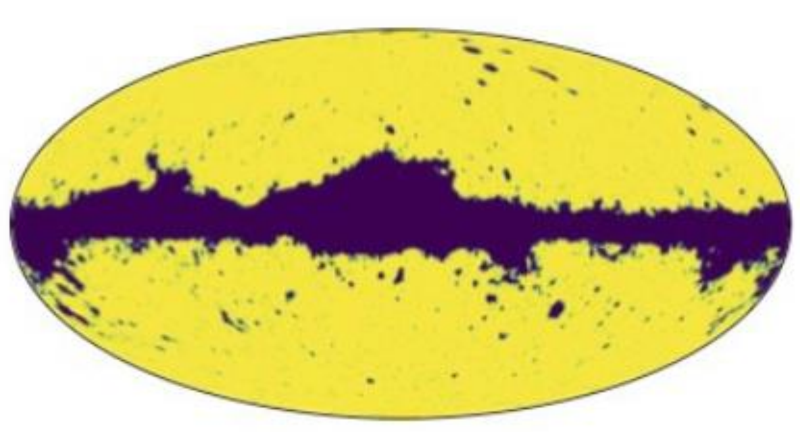

Figure 1.
Simulated mask for an all-sky survey like SPHEREx.

Figure 2.
Simulated mask for a survey like Euclid.

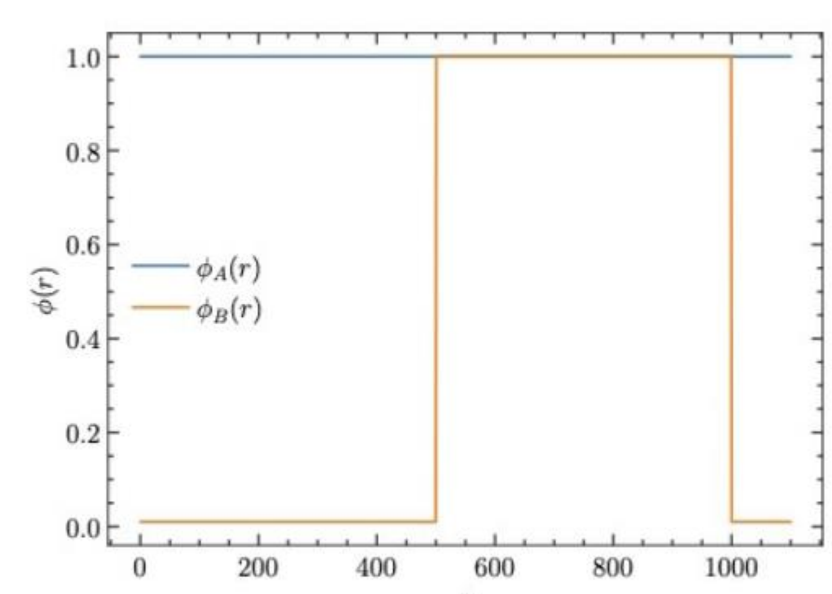

Figure 3.
Simulated simplistic radial selection functions for both a survey like SPHEREx (A) and Euclid (B).

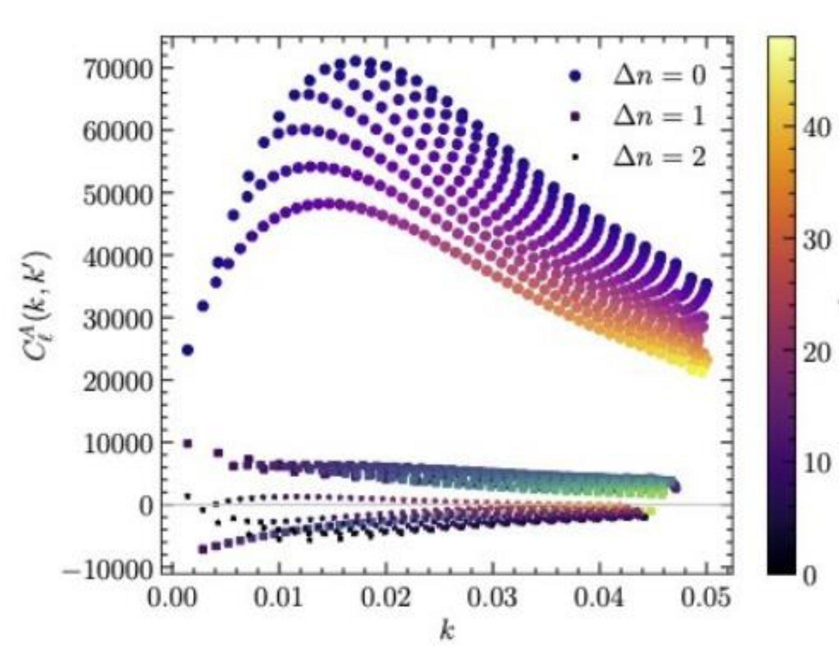

Figure 4.
SFB decomposition of all sky simulated SPHEREx data.

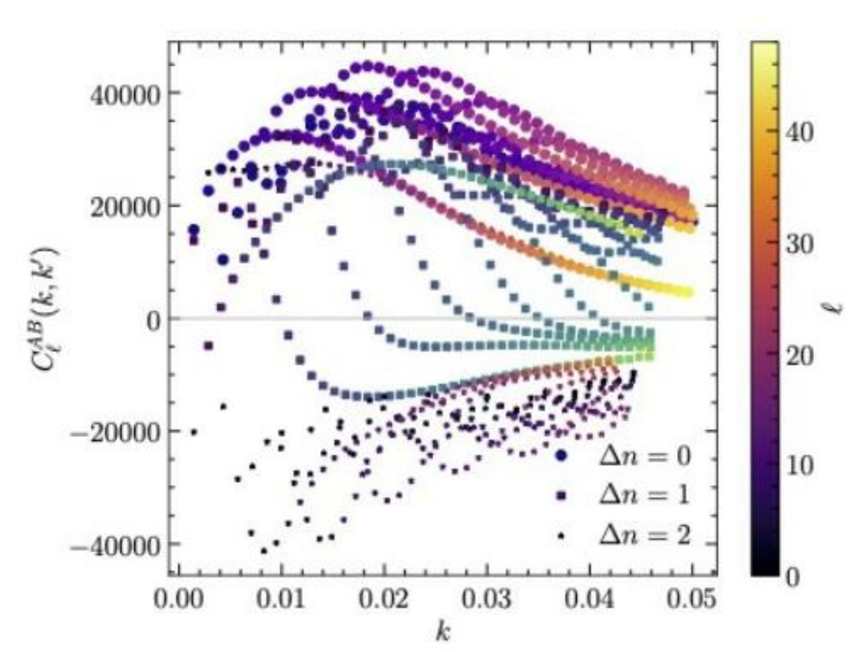

Figure 5.
SFB decomposition of the cross--correlation between SPHEREx and Euclid simulated data.

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RPD-000 Clearance Number: CL#00-0000

Publications:
Beutler & Castorina: arXiv:1810.05051
Gebhardt & Doré, arXiv:2310.17677, 2109.13352
Khek, Gebhardt, Doré, arXiv:2212.05760

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