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An Iterative Multi-scale Method for the Approximation and Inversion of Gravitational Data on the Sphere

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Based on an orthogonal matching pursuit, we propose a novel method which iteratively chooses spherical trial functions out of a large redundant set of functions (dictionary) to best match the signal. The method is capable of combining arbitrary spherical basis functions which is a great advantage to former approximation algorithms. In particular, we use spherical harmonics to reconstruct global trends as well as localized trial functions, such as the Abel-Poisson scaling function and wavelets with different scales, to represent more detailed structures of the gravitational field. Meanwhile, the solution is stabilized with a particularly chosen penalty term. The outcome is a smooth and sparse approximation of the unknown field which is locally adapted to the detail structure of the signal as well as to the data density. Moreover, we obtain a multiresolution analysis of the signal such that we are able to look at the solution at different scales. Numerical experiments are presented.