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Towards a faster spherical harmonic transform

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Several fast spherical harmonics algorithm have been proposed in the past decades. However, their use has not spread, showing that they still suffer of limitations.

First, their speed advantage only appears for quite large cutoffs degree (around 512). They often lack a vector transform, have no flexible interface, and some of them have stability problems.

On the other hand, the Gauss-Legendre algorithm requires less grid points for an exact quadrature and is computationnaly very efficient if one precompute everything.

The new algorithm and implementation presented here is aimed at numerical simulations. It is not a fast algorithm as it has almost the same complexity as the Gauss-Legendre one. However, it is faster, and mostly efficient for anisotropic truncation, that is relevant for fast rotating fluids. It makes use of a regular grid, while using almost the same amount of point for an exact quadrature as the Gauss-Legendre algorithm.

We compare its speed with a highly opitmized Gauss-Legendre transform, and make other suggestions for improving the speed of numerical simulations in spherical shells. We also propose a highly optimized reference implementation, with both scalar and vector transform, and a flexible interface.