Globes is a modular open-source software library for simulating short- and long-baseline neutrino oscillation experiments, and for studying the oscillation phenomenology.

**What Globes can do:**
- Compute 3-flavour oscillation probabilities in matter
- Simulate event spectra for reactor experiments, super-beams, beta beams, neutrino factories, ...
- Perform sophisticated $\chi^2$ analyses
- Adapt to the user's needs

**What Globes cannot (yet) do:**
- Replace a detector Monte Carlo simulation
- Simulate solar and atmospheric neutrinos

### Oscillations

The oscillation engine is the heart of the software. Its main features are:
- Full three-flavour treatment
- Arbitrary (non-adiabatic) matter profiles
- The PREM (Preliminary Reference Earth Model) matter profile is hard-coded in Globes.
- The user can choose approximations to this profile (e.g. constant density, mantle-core-mantle profile, etc.) or define completely new profiles.
- High numerical efficiency

Globes uses specifically designed numerical algorithms to ensure an excellent performance, which is for the specific problem of neutrino oscillations, far superior to that of "back-test" libraries.

**Extrapolability**

The user has the possibility to modify or completely replace the Globes oscillation engine, e.g. to include sterile neutrinos, non-standard interactions, and other kinds of "new physics".

### $\chi^2$ analysis

Globes uses the $\chi^2$ method to extract physical information from the simulated event spectra. Main features are:
- Cuts and projections of the multi-dimensional $\chi^2$ manifold ("simulation")
- Inclusion of systematical uncertainties (fully customizable)
- Inclusion of correlations and degeneracies
- Inclusion of external priors (fully customizable)
- Supports setups with Multiple sources and multiple detectors
- Excellent numerical efficiency

The built-in $\chi^2$ functions of Globes have the Poissonian form

$$\chi^2(\tilde{\lambda}, \tilde{a}) = 2 \sum \sum \left[ N_i(\lambda, a) - N_{th}(\lambda, a) \right] + \chi_{sys}^2$$

where $N_{th}$ and $N_{obs}$ are the "observed" and theoretically predicted event rates, respectively. The vector $\lambda$ contains the oscillation parameters, and $\chi_{sys}$ are the systematical biases $\chi_{sys1}$ and $\chi_{sys2}$ that implement external input on these parameters. Note that Globes allows also for arbitrary, user-defined $\chi^2$ functions.

**Examples:** $\theta_{13} - \Delta m^2$ correlation and intrinsic degeneracy in a $\sigma$-fact.

### Recent Globes results

- Evolution of $\Delta m_{31}^2$ disc. reach & sensitivity of different exp's
- Sensitivity of $\Delta m_{31}^2$ to standard and non-standard physics

### GLOBE website:

www.mpi-hd.mpg.de/~globes/

- Software download
- Many predefined AEDL files
- Extensive documentation
- Examples and tutorials

### GLOBE publications:

CPC 167, 195 (2005), hep-ph/0407333
CPC 177, 432 (2007), hep-ph/0701187

Contact the authors:

globes@mpi-hd.mpg.de

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Patrick Huber\textsuperscript{1,2}, Joachim Kopp\textsuperscript{3}, Manfred Lindner\textsuperscript{2}, Walter Winter\textsuperscript{4}

**GLOBE**

General Long Baseline Experiment Simulator

\textsuperscript{1} Physics Department, Theory Division, CERN, CH-1211 Geneva 23, Switzerland
\textsuperscript{2} Department of Physics, Virginia Tech, Blacksburg, VA 24061, USA
\textsuperscript{3} Max Planck-Institut für Kernphysik, Postfach 10 39 80, 69029 Heidelberg, Germany
\textsuperscript{4} Institut für Theoretische Physik und Astrophysik, Universität Würzburg, 97074 Würzburg, Germany