file organization

The datas of the previous project are organized as follow:

- The datas are stored in a folder named **f_#_L_#_tau_1_N_#_kmax_#_nat_tau**, inside which contains the folders **ndsolve**, **parameters**, **GF_new**, **ClBB_rei_accurate**, **ClTT_rei_scalar_matter** and **ClTT_rei_tensor**, and also a *parameters.mx* file (which is easier to read for Mathematica) containing some parameters of this benchmark model.
- The **ndsolve** folder contains the solved axion field and gauge modes and their conformal time derivatives.
- The **parameters** folder has the time grid information of the solved axion field/gauge modes and the discretized k-mode.
- The **GF_new** folder contains the Green's function for the tensor mode calculations.
- The remaining three folders, as can be seen from their names, contains the results of the B-mode, anisotropy from scalar and tensor modes respectively. Each of them has a **func_f_#** folder containing the f functions (defined in the paper) of the corresponding mode, and a bunch of **uu_#** folder containing the results of a certain momentum k (the # in the folder name is the index of the k-mode).

supporting codes and data

- **tab_a_tau.dat, tab_ap_tau.dat, tab_appoa_tau.dat, tab_aH_tau.dat** Lists of $a(\tau)$, $a'(\tau)$, a''/a and aH.
- **ndsolve_qua_natural_true_tau.m** The code solving for the mode functions. The parameters used for evaluation is dumped into *parameter.mx* for later use.
- **extract_grid_tau.m** To extract the τ-grids of the solved mode function. Also dump some other parameters in plain text.
- **extract_vprime.m** To extract the conformal time derivatives of the gauge modes.
- **calc_GF_tensor.m** Calculating the Green function $G(k, \tau, \tau')$ which is used in the tensor mode calculations (see the other notes). The function G has the boundary conditions $G(k, \tau', \tau') = 0$ and $G'(k, \tau', \tau') = 1$. Instead of numerically solving for G at every τ', we solve for two GFs G_1 and G_2 with a fixed boundary $\tau' = \tau_{\rm osc}$, which has the boundary conditions $G_{1(2)}(k, \tau', \tau') = 0(1)$ and $G'_{1(2)}(k, \tau', \tau') = 1(0)$ respectively. Then G can be expressed as

$$G(k, \tau, \tau') = G_2(k, \tau')G_1(k, \tau) - G_1(k, \tau')G_2(k, \tau)\,. \tag{1}$$

It can be shown that $G_2(k,\tau)G_1'(k,\tau) - G_1(k,\tau)G_2'(k,\tau) \equiv 1$, which make the G' boundary condition work.

codes for B-mode

- **calcCBB_func_f_GF.m** Calculating the function (see the ClBB note+the Fourier note)

$$f(k,\tau') = \int_{\tau'}^{\tau_{\rm rei}} d\tau \frac{1}{a}\mathcal{G}(k,\tau,\tau')\frac{j_2[k(\tau_{\rm rei}-\tau)]}{k^2(\tau_{\rm rei}-\tau)^2}\,, \tag{2}$$

  as a function of k and τ'.

- **calcCBB_rei_accurate_GF.m** Calculating the B-mode spectrum as a function of k and q, with the function f calculate above (See the Fourier note).
- **collectCBB_rei_accurate_GF.m** Summing the result from the code above over k and q.

codes for tensor T-mode

- **calcCTT_tensor_func_f_GF_2.m** Calculating the corresponding function f_l for the tensor TT-spectrum (as above, but with $j_2 \to j_l$ and $\tau_{\rm rei} \to \tau_0$). The suffix "_2" is a version label.
- **calcCTT_rei_uncut_tensor_GF_2.m** Similar to the B-mode case, calculating the tensor TT-spectrum as a function of k and q.
- **collectCTT_rei_tensor_GF.m** Summing the result from the code above over k and q.

codes for scalar T-mode

- **calcCTT_scalar_func_f_matter.m** To calculate the corresponding function f_l for the scalar TT-spectrum, after including the matter component.
- **calcCTT_rei_uncut_scalar_matter_correct.m** With the function f_l calculated above, this piece of code calculates the scalar TT spectrum as a function of k and q.
- **collectCTT_rei_scalar_tau_new.m** Summing the results from the code above.