

/Users/lplopa/Compare/camb_simdata/lensing.f90, Top line: 1

```
0001 !Lensing the C_l using the de  
0002 !power spectrum.  
0003 !lensing_method=1: using an a  
0004 !lensing_method=2: using the  
0005 !                                and astro-  
0006 !lensing_method=3: using inac  
0007  
0008 !The flat sky result is accur  
0009 !about a factor of two faster  
0010 !lensing_method=3 is only pre  
0011  
0012 !Set accurate_BB=T if you wan  
0013 !otherwise it saves a large a  
0014 !accute_BB only does *not* in  
0015 !chosen sufficiently high l_m  
0016 !result  
0017  
0018 !Uses the un-lensed Cls and t  
0019 !Usual values of k_max are fi  
0020 !To get the lensed BB accurat  
0021 !higher for higher l. Since t  
0022 !also need to go to higher k_  
0023 !k_eta_max_scalar=10000. At l  
0024 !non-linear evolution to caus  
0025  
0026 !Correlation function routine  
0027 !Curved sky results use the m  
0028  
0029 !Full sky harmonic lensing ro  
0030 !Ref: astro-ph/0001303 by W.
```

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```
0001 !Lensing the C_l using th  
0002 !power spectrum.  
0003 !lensing_method=1: using  
0004 !lensing_method=2: using  
0005 !                                and as  
0006 !lensing_method=3: using  
0007  
0008 !The flat sky result is a  
0009 !about a factor of two fa  
0010 !lensing_method=3 is only  
0011  
0012 !Set accurate_BB=T if you  
0013 !otherwise it saves a lar  
0014 !accute_BB only does *not  
0015 !chosen sufficiently high  
0016 !result  
0017  
0018 !Uses the un-lensed Cls a  
0019 !Usual values of k_max ar  
0020 !To get the lensed BB acc  
0021 !higher for higher l. Sin  
0022 !also need to go to highe  
0023 !k_eta_max_scalar=10000.  
0024 !non-linear evolution to  
0025  
0026 !Correlation function rou  
0027 !Curved sky results use t  
0028  
0029 !Full sky harmonic lensin  
0030 !Ref: astro-ph/0001303 by
```

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```
0031 !For better derivations see a  
0032 !Adapted for CAMB and optimiz  
0033 !Uses f90 version of "J1-RECU  
0034 !obtainable from the CPC prog  
0035  
0036 !March 2006: fixed problem wi  
0037  
0038 module lensing  
0039 use Precision  
0040 use ModelParams  
0041 use AmlUtils  
0042 implicit none  
0043 integer, parameter :: lensin  
0044 lensin  
0045  
0046 integer :: lensing_method =  
0047  
0048 real(dl) :: ALens_Fiducial =  
0049 !Change from zero to set len  
0050  
0051 private  
0052  
0053 logical :: lensing_includes  
0054  
0055 !flat method stores  
0056 real(dl), parameter :: dbess  
0057 real(dl), dimension(:), allo  
0058 real(dl), dimension(:), allo
```

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```
0031 !For better derivations s  
0032 !Adapted for CAMB and opt  
0033 !Uses f90 version of "J1-  
0034 !obtainable from the CPC  
0035  
0036 !March 2006: fixed proble  
0037  
0038 module lensing  
0039 use Precision  
0040 use ModelParams  
0041 use AmlUtils  
0042 implicit none  
0043 integer, parameter :: len  
0044 lensing_method_harmon  
0045  
0046 integer :: lensing_method  
0047  
0048 real(dl) :: lensing_sanit  
0049  
0050 real(dl) :: ALens_Fiducia  
0051 !Change from zero to set  
0052  
0053 private  
0054  
0055 logical :: lensing_inclu  
0056  
0057 !flat method stores  
0058 real(dl), parameter :: db  
0059 real(dl), dimension(:), a  
0060 real(dl), dimension(:), a
```

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```
0059      real(dl), dimension(:), allo  
0060      real(dl), dimension(:), allo  
0061  
0062      integer, parameter :: lensed  
          !Number of L less than L m  
0064  
0065      !Harmonic method stores  
          integer :: lmax_donelnfa = 0  
0066      real(dl), dimension(:), allo  
0068  
0069      public lens_Cls, lensing_incl  
          lensing_method_curv_cor  
0070  
0071      contains  
0072  
0073  
0074      subroutine lens_Cls  
0075          use lvalues  
0076  
0077          !Must set l again in case co  
          call initlval(lSamp,CP%Max_l  
0078          if (lensing_method == lensin  
              call CorrFuncFullSky()  
0080          elseif (lensing_method == 1  
              call CorrFuncFlatSky()  
0082          elseif (lensing_method == 1  
              call BadHarmonic  
0084          else  
              stop 'Unknown lensing met  
0086          end if
```

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```
0061      real(dl), dimension(:), a  
0062      real(dl), dimension(:), a  
0063  
0064      integer, parameter :: len  
          !Number of L less than L m  
0066  
0067      !Harmonic method stores  
          integer :: lmax_donelnfa  
          real(dl), dimension(:), a  
0068  
0069  
0070  
0071      public lens_Cls, lensing_  
          lensing_method_curv_c  
          lensing_sanity_check_  
          contains  
0072  
0073  
0074  
0075  
0076  
0077  
0078  
0079  
0080  
0081  
0082  
0083  
0084  
0085  
0086  
0087  
0088  
0089      error stop 'Unknown l  
0090      end if
```

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```
0088 end subroutine lens_Cls
0089
0090
0091 subroutine CorrFuncFullSky
0092
0093     integer :: lmax_extrap
0094
0095     lmax_extrap = CP%Max_l - 1
0096     if (HighAccuracyDefault) lmax_extrap = min(lmax_extrap, CP%Max_l)
0097     lmax_extrap = min(lmax_extrap, CP%Max_l)
0098     call CorrFuncFullSkyImpl(max_l, max_theta, lmax_extrap, lmax, npoints,
0099                               corr, Cg2, sigma, dtheta, llp1, fac, fac1, fac2)
0100 end subroutine CorrFuncFullSky
0101
0102
0103 subroutine CorrFuncFullSkyImp
0104 !Accurate curved sky correlation function
0105 !Uses non-perturbative isotropic source
0106 !Neglects C_{gl}(theta) term
0107 use ModelParams
0108 use ModelData
0109 use lvalues
0110 implicit none
0111 integer, intent(in) :: lmax
0112 integer l, i, in
0113 integer :: npoints
0114 real(dl) corr(4), Cg2, sigma
0115 real(dl) dtheta
0116 real(dl) llp1, fac, fac1, fac2
0117 integer max_lensed_ix
```

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```
0091 end subroutine lens_Cls
0092
0093
0094 subroutine CorrFuncFullSky
0095
0096     integer :: lmax_extrap
0097
0098     lmax_extrap = CP%Max_l - 1
0099     if (HighAccuracyDefault) lmax_extrap = min(lmax_extrap, CP%Max_l)
0100     lmax_extrap = min(lmax_extrap, CP%Max_l)
0101     call CorrFuncFullSkyImpl(max_l, max_theta, lmax_extrap, lmax, npoints,
0102                               corr, Cg2, sigma, dtheta, llp1, fac, fac1, fac2)
0103 end subroutine CorrFuncFullSky
0104
0105
0106 subroutine CorrFuncFullSky
0107 !Accurate curved sky correlation function
0108 !Uses non-perturbative isotropic source
0109 !Neglects C_{gl}(theta) term
0110 use ModelParams
0111 use ModelData
0112 use lvalues
0113 implicit none
0114 integer, intent(in) :: lmax
0115 integer l, i, in
0116 integer :: npoints
0117 real(dl) corr(4), Cg2, sigma
0118 real(dl) dtheta
0119 real(dl) llp1, fac, fac1, fac2
0120 integer max_lensed_ix
```

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```
0118      real(dl) P(lmax),dP(lmax)
0119      real(dl) sinth,halfsinth, x
0120      real(dl) roots(-1:lmax+4),
0121      real(dl) d_11(lmax),d_m11(l
0122      real(dl) d_22(lmax),d_2m2(l
0123      real(dl) Cphil3(lmin:lmax),
0124      real(dl) ls(lmax)
0125      real(dl) xl(lmax)
0126      real(dl), allocatable :: dd
0127      real(dl), allocatable :: le
0128      integer thread_ix
0129      real(dl) pmm, pmmp1
0130      real(dl) d4m4,d11,dm11,d2m2
0131      real(dl) sinfac, Cg2sq
0132      real(dl) x000,x022,x220,x12
0133      real(dl) dx000,dx022
0134      real(sp) timeprev
0135      integer interp_fac
0136      integer j,jmax
0137      integer llo, lhi
0138      real(dl) a0,b0,ho, sc
0139      integer apodize_point_width
0140      logical :: short_integral_r
0141      real(dl) range_fac
0142      logical, parameter :: appro
0143
0144      !$ integer OMP_GET_THREAD_NU
0145      !$ external OMP_GET_THREAD_NU
0146
```

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```
0121      real(dl) P(lmax),dP(lmax)
0122      real(dl) sinth,halfsinth,
0123      real(dl) roots(-1:lmax+4)
0124      real(dl) d_11(lmax),d_m11
0125      real(dl) d_22(lmax),d_2m2
0126      real(dl) Cphil3(lmin:lmax)
0127      real(dl) ls(lmax)
0128      real(dl) xl(lmax)
0129      real(dl), allocatable :::
0130      real(dl), allocatable :::
0131      integer thread_ix
0132      real(dl) pmm, pmmp1
0133      real(dl) d4m4,d11,dm11,d2
0134      real(dl) sinfac, Cg2sq
0135      real(dl) x000,x022,x220,x
0136      real(dl) dx000,dx022
0137      real(sp) timeprev
0138      integer interp_fac
0139      integer j,jmax
0140      integer llo, lhi
0141      real(dl) a0,b0,ho, sc
0142      integer apodize_point_wid
0143      logical :: short_integral
0144      real(dl) range_fac
0145      logical, parameter :: app
0146      real(dl) theta_cut(lmax)
0147
0148      !$ integer OMP_GET_THREAD_NU
0149      !$ external OMP_GET_THREAD_NU
0150
```

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```
0147      if (lensing_includes_tens
0148
0149      max_lensed_ix = lSamp%10-
0150      do while(lSamp%1(max_lens
0151          max_lensed_ix = max_len
0152      end do
0153      lmax_lensed = lSamp%1(max_
0154      if (allocated(Cl_lensed))
0155          allocate(Cl_lensed(lmin:1
0156
0157      Cl_Lensed = 0
0158
0159      npoints = CP%Max_1 * 2 *
0160      short_integral_range = .n
0161      dtheta = pi / npoints
0162      if (CP%Max_1 > 3500) dthe
0163          apodize_point_width = nin
0164          npoints = int(pi/dtheta)
0165          if (short_integral_range)
0166              range_fac= max(1._dl,3
0167              npoints = int(npoints
0168              !OK for TT, EE, TE but
0169              !this induces high freq
0170              !which is then mitigate
0171          else
0172              range_fac=1
0173          end if
0174
0175      if (DebugMsgs) timeprev=G
0176
0177
0178
0179
0180
```

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```
0151      if (lensing_includes_tens
0152
0153      max_lensed_ix = lSamp%10-
0154      do while(lSamp%1(max_lens
0155          max_lensed_ix = max_l
0156      end do
0157      lmax_lensed = lSamp%1(max_
0158      if (allocated(Cl_lensed))
0159          allocate(Cl_lensed(lmin:1
0160
0161      Cl_Lensed = 0
0162
0163      npoints = CP%Max_1 * 2 *
0164      short_integral_range = .n
0165      dtheta = pi / npoints
0166      if (CP%Max_1 > 3500) dthe
0167          apodize_point_width = nin
0168          npoints = int(pi/dtheta)
0169          if (short_integral_range)
0170              range_fac= max(1._dl,
0171              npoints = int(npoints
0172              !OK for TT, EE, TE bu
0173              !this induces high fr
0174              !which is then mitiga
0175          else
0176              range_fac=1
0177          end if
0178
0179
0180
```

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```
0177      interp_fac = max(1,min(ni
0178
0179      jmax = 0
0180      do l=lmin,lmax
0181          if (l<=15 .or. mod(l-1
0182              jmax =jmax+1
0183              ls(jmax)=1
0184              xl(jmax)=1
0185          end if
0186          lfacs(l) = real(l*(l+1
0187          lfacs2(l) = real((l+2)
0188          lrootfacs(l) = sqrt(lf
0189      end do
0190
0191      roots(-1)=0 !just so dipo
0192      do l=0,lmax+4
0193          roots(l) = sqrt(real(l,d
0194      end do
0195
0196
0197      thread_ix = 1
0198      !$ thread_ix = OMP_GET_MA
0199      allocate(lens_contrib(4,l
0200      allocate(ddcontribs(lmax,
0201
0202      do in = 1, CP%InitPower%n
0203
```

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```
0181      interp_fac = max(1,min(ni
0182
0183      jmax = 0
0184      do l=lmin,lmax
0185          if (l<=15 .or. mod(l-
0186              jmax =jmax+1
0187              ls(jmax)=1
0188              xl(jmax)=1
0189          end if
0190          lfacs(l) = real(l*(l+
0191          lfacs2(l) = real((l+2
0192          lrootfacs(l) = sqrt(l
0193      end do
0194
0195
0196
0197      roots(-1)=0 !just so dipo
0198      do l=0,lmax+4
0199          roots(l) = sqrt(real(l,
0200
0201
0202
0203
0204
0205
0206
0207
0208
0209
0210
```

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```
0204      do l=lmin,CP%Max_l  
0205          ! (2*l+1)l(l+1)/4pi C_ph  
0206          Cphil3(l) = Cl_scalar(  
0207              fac = (2*l+1)/(4*pi) *  
0208              CTT(l) = Cl_scalar(l,  
0209              CEE(l) = Cl_scalar(l,  
0210              CTE(l) = Cl_scalar(l,  
0211      end do  
0212      if (Cphil3(10) > 1e-7) th  
0213          write (*,*) 'You need to  
0214          write (*,*) 'see http://  
0215          stop  
0216      end if  
0217      if (lmax > CP%Max_l) then  
0218          l=CP%Max_l  
0219          sc = (2*l+1)/(4*pi) * 2*  
0220          fac2=CTT(CP%Max_l)/(sc*h)  
0221          fac=Cphil3(CP%Max_l)/(sc  
0222          do l=CP%Max_l+1, lmax  
0223              !Fill in tail from tem  
0224              sc = (2*l+1)/(4*pi) *  
0225              Cphil3(l) = highL_CL_t  
0226  
0227              CTT(l) = highL_CL_tem  
0228              CEE(l) = highL_CL_tem  
0229              CTE(l) = highL_CL_tem  
0230              if (Cphil3(CP%Max_l+1)  
0231                  write (*,*) 'You need  
0232                  stop  
0233      end if
```

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```
0211      do l=lmin,CP%Max_l  
0212          ! (2*l+1)l(l+1)/4  
0213          Cphil3(l) = Cl_sc  
0214          fac = (2*l+1)/(4*  
0215          CTT(l) = Cl_scal  
0216          CEE(l) = Cl_scal  
0217          CTE(l) = Cl_scal  
0218      end do  
0219      if (Cphil3(10) > lens  
0220          write (*,*) 'You  
0221          write (*,*) 'see  
0222          call MPIStop()  
0223      end if  
0224      if (lmax > CP%Max_l)  
0225          l=CP%Max_l  
0226          sc = (2*l+1)/(4*p  
0227          fac2=CTT(CP%Max_l  
0228          fac=Cphil3(CP%Max  
0229          do l=CP%Max_l+1,  
0230              !Fill in tail  
0231              sc = (2*l+1)/  
0232              Cphil3(l) = h  
0233  
0234              CTT(l) = hig  
0235              CEE(l) = hig  
0236              CTE(l) = hig  
0237              if (Cphil3(CP  
0238              call Mpis  
0239      end if
```

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```
0234      end do  
0235      end if  
0236      if (ALens_Fiducial > 0) then  
0237          do l=2, lmax  
0238              sc = (2*l+1)/(4*pi)  
0239              Cphil3(l) = sc * h  
0240          end do  
0241      end if  
0242  
0243      lens_contrib=0  
0244  
0245      !uncomment second line for  
0246      !$OMP PARALLEL DO DEFAULT(P  
0247      !$OMP PRIVATE(P,dP,d11,dm11,  
0248      !$OMP SHARED(lfacs,lfacs2,l  
0249      !$OMP SHARED(dtheta,CP,lmax  
0250          do i=1,npoints-1  
0251  
0252          theta = i * dtheta  
0253          x = cos(theta)  
0254          synth = sin(theta)  
0255          halfsinth = synth/2  
0256  
0257          pmm=1  
0258          pmmp1=x  
0259  
0260          Cg2=0  
0261          sigmasq=0  
0262          if (lmin==1) then  
0263              d_11(1) = cos(theta/2
```

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```
0240      end do  
0241      end if  
0242      if (ALens_Fiducial >  
0243          do l=2, lmax  
0244              sc = (2*l+1)/  
0245              Cphil3(l) =  
0246          end do  
0247      end if  
0248  
0249      lens_contrib=0  
0250  
0251      !uncomment second lin  
0252      !$OMP PARALLEL DO DEF  
0253      !$OMP PRIVATE(P,dP,d11  
0254      !$OMP SHARED(lfacs,lf  
0255      !$OMP SHARED(dtheta,C  
0256          do i=1,npoints-1  
0257  
0258          theta = i * dtheta  
0259          x = cos(theta)  
0260          synth = sin(theta)  
0261          halfsinth = synth  
0262  
0263          pmm=1  
0264          pmmp1=x  
0265  
0266          Cg2=0  
0267          sigmasq=0  
0268          if (lmin==1) then  
0269              d_11(1) = cos
```

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```
0264      d_m11(1) = sin(theta/
0265      sigmasq = sigmasq +
0266      Cg2 = Cg2 + d_m11(1)
0267      P(1) = x
0268      d_22(1)=0
0269      d_2m2(1)=0
0270      d_20(1)=0
0271      end if
0272      do l=2,lmax
0273
0274      P(l)= ((2*l-1)* x *pm
0275      dP(l) = 1*(pmmp1-x*P(
0276      Pmm=pmmp1
0277      pmmp1=P(l)
0278      llp1 = lfacs(l)
0279
0280      fac1 = (1-x)
0281      fac2 = (1+x)
0282      fac = fac1/fac2
0283
0284      d_11(l) = fac1*dP(l)
0285      d_m11(l) = fac2*dP(l)
0286
0287      sigmasq = sigmasq +
0288      Cg2 = Cg2 + d_m11(l)
0289
0290      d_22(l) = ( ((4*x-8)/
0291          + 4*fac*( fac2 +
0292
```

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```
0270      d_m11(1) = si
0271      sigmasq = sig
0272      Cg2 = Cg2 +
0273      P(1) = x
0274      d_22(1)=0
0275      d_2m2(1)=0
0276      d_20(1)=0
0277      end if
0278      do l=2,lmax
0279
0280      P(l)= ((2*l-1
0281      dP(l) = 1*(pm
0282      Pmm=pmmp1
0283      pmmp1=P(l)
0284      llp1 = lfacs(
0285
0286      fac1 = (1-x)
0287      fac2 = (1+x)
0288      fac = fac1/fa
0289
0290      d_11(l) = fa
0291      d_m11(l) = fa
0292
0293      sigmasq = sig
0294      Cg2 = Cg2 +
0295
0296      d_22(l) = ( (
0297          + 4*fac*(
0298
0299 !For small th
```

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```
0293      d_2m2(l) = ( llp1- (  
0294          +4/fac*( -fac1 +  
  
0295  
0296      d_20(l) = (2*x*dP(l)  
0297      end do  
0298      do j=1,jmax  
0299          l =ls(j)  
0300          fac1 = (1-x)  
0301          fac2 = (1+x)  
0302          llp1 = lfacs(l)  
0303          rootllp1 = roots(l)*r  
0304          rootfac1 = roots(l+2)  
0305          rootfac2 = roots(l+3)  
0306          llp1=lfacs(l)  
0307          dm11=d_m11(l)  
0308          d11=d_11(l)  
0309          if (l<2) then  
0310              d2m2=0  
0311              d22=0  
0312              d20=0
```

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```
0300      if (theta > t  
0301          d_2m2(l)  
0302          +4/fa  
0303      else  
0304          d_2m2(l)  
0305          - (3.  
0306      endif  
0307  
0308      d_20(l) = (2*  
0309      end do  
0310      do j=1,jmax  
0311          l =ls(j)  
0312          fac1 = (1-x)  
0313          fac2 = (1+x)  
0314          llp1 = lfacs(  
0315          rootllp1 = ro  
0316          rootfac1 = ro  
0317          rootfac2 = ro  
0318          llp1=lfacs(l)  
0319          dm11=d_m11(l)  
0320          d11=d_11(l)  
0321          if (l<2) then  
0322              d2m2=0  
0323              d22=0  
0324              d20=0
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 318

```
0318      d1m2 = 0
0319      d12 = 0
0320  else
0321      d2m2=d_2m2(1)
0322      d22=d_22(1)
0323      d20=d_20(1)
0324      d1m2 = sinh/rootfac
0325      d12 = sinh/rootfac
0326  end if
0327  if (l<3) then
0328      d1m3=0
0329      d2m3=0
0330      d3m3=0
0331      d13 =0
0332      d23 =0
0333      d33 =0
0334  else
0335      sinfac=4/sinh
0336      d1m3 = -(x+0.5_d1)*
0337      d2m3 = (-fac2*d2m2*s
0338      d3m3 = -(x+1.5_d1)*
0339      d13 = ((x-0.5_d1)*
0340      d23 = (-fac1*d22*si
0341      d33 = -(x-1.5_d1)*
0342  end if
0343  if (l<4) then
0344      d04=0
0345      d2m4=0
0346      d4m4=0
0347      rootfac3=0
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 330

```
0330      d1m2 = 0
0331      d12 = 0
0332  else
0333      d2m2=d_2m
0334      d22=d_22(
0335      d20=d_20(
0336      d1m2 = si
0337      d12 = si
0338  end if
0339  if (l<3) then
0340      d1m3=0
0341      d2m3=0
0342      d3m3=0
0343      d13 =0
0344      d23 =0
0345      d33 =0
0346  else
0347      sinfac=4/
0348      d1m3 = (-
0349      d2m3 = (-
0350      d3m3 = (-
0351      d13 = (
0352      d23 = (
0353      d33 = (
0354  end if
0355  if (l<4) then
0356      d04=0
0357      d2m4=0
0358      d4m4=0
0359      rootfac3=
```

/Users/lplopa/Compare/camb_simdata/lensing.f90, Top line: 348

```

0348
0349
0350
0351
0352
0353
0354
0355
0356
0357 !Non perturbative isot
0358 !these are approx, but
0359 x000 = exp(-llp1*sig
0360 if (approx) then
0361
0362 x022 = x000
0363 x220 = rootllp1**2/4
0364 x121 = -0.5_dl*rootl
0365 x132 = -0.5_dl*rootl
0366 x242 = 0.25_dl*rootl
0367
0368 dx000 = -llp1/4*x000
0369 dx022 = -llp1/4*x022
0370
0371
0372 else
0373 x022 = x000*(1+sigma
0374 x220 = lrootfac(1)/
0375 x121 = -0.5_dl*rootf
0376 x132 = -0.5_dl*rootf
0377 x242 = 0.25_dl*rootf

```

/Users/lplopa/Compare/camb_des/lensing.f90, Top line: 360

```
0360  
0361  
0362  
0363  
0364  
0365  
0366  
0367  
0368  
0369  
0370  
0371  
0372  
0373  
0374  
0375  
0376  
0377  
0378  
0379  
0380  
0381  
0382  
0383  
0384  
0385  
0386  
0387  
0388  
0389  
  
else  
    rootfac3=  
    d04=(-1  
          6*x*1  
    d2m4= (-(  
    d4m4 = (-  
          12/5.  
end if  
  
!Non perturba  
!these are ap  
x000 = exp(-1  
if (approx) t  
  
x022 = x0  
x220 = ro  
x121 = -0  
x132 = -0  
x242 = 0.  
  
dx000 = -  
dx022 = -  
  
else  
    x022 = x0  
    x220 = lr  
    x121 = -0  
    x132 = -0  
    x242 = 0.
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 378

```
0378  
0379          dx000 = -llp1/4*x000  
0380          dx022 = (1-llp1/4)*x  
0381      end if  
0382 !second order  
0383     !TT  
0384     fac1 = dx000**2  
0385     fac3 = x220**2  
0386     Cg2sq = Cg2**2  
0387  
0388 !Here we drop terms in Cgt wh  
0389 !Approx good to 1e-4 level  
0390     fac = ( (x000**2-1)  
0391           + 8/llp1*  
0392  
0393     corrcontribs(j,1)=  
0394  
0395     !Q+U  
0396         fac2=(Cg2*dx022)**2+  
0397         fac = 2*Cg2*X121*X13  
0398  
0399     corrcontribs(j,2)= C  
0400  
0401 !Q-U  
0402         fac = ( fac3*P(1) +  
0403           + Cg2*(X121**2*  
0404  
0405         corrcontribs(j,3)= C  
0406  
0407 !TE
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 390

```
0390  
0391  
0392  
0393  
0394  
0395  
0396  
0397  
0398  
0399  
0400  
0401  
0402  
0403  
0404  
0405  
0406  
0407  
0408  
0409  
0410  
0411  
0412  
0413  
0414  
0415  
0416  
0417  
0418  
0419  
dx000 = -  
dx022 = (  
end if  
!second order  
!TT  
fac1 = dx000*  
fac3 = x220**  
Cg2sq = Cg2**  
  
!Here we drop  
!Approx good  
fac = ( (x000  
+ 8/llp1*  
  
corrcontribs(  
  
fac2=(Cg2*dx0  
!Q+U  
fac = 2*Cg2*X  
  
corrcontribs(  
  
!Q-U  
fac = ( fac3*  
+ Cg2*(X1  
  
corrcontribs(  
  
!TE
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 408

```
0408      fac = (X000*X022-1)*d  
0409          2*dx000*Cg2*(X121*d  
0410          + Cg2sq*(X220/2*  
0411  
0412      corrcontribs(j,4)= CT  
0413  
0414      end do  
0415  
0416      do j=1,4  
0417          corr(j) = sum(corrcontribs(  
0418      end do  
0419  
0420      !if (short_integral_range .an  
0421          !           corr=corr*exp(-(i-np  
0422  
0423      if (short_integral_range .and  
0424          corr=corr*exp(-(i-npo  
0425              !taper the end to  
0426  
0427  
0428      !Interpolate contributions  
0429      !Increasing interp_fac and us  
0430      if (.false.) then  
0431          if (abs(sum(corrcontrib  
0432          do j=1,4  
0433              call spline(xl,corrcon  
0434          end do  
0435          corr=0  
0436          llo=1  
0437          do l=lmin,lmax
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 420

```
0420      fac = (X000*X022-1)*d  
0421          2*dx000*C  
0422          + Cg2sq*(  
0423  
0424      corrcontribs(  
0425  
0426      end do  
0427  
0428      do j=1,4  
0429          corr(j) = sum  
0430      end do  
0431  
0432      !if (short_integr  
0433          !           corr=cor  
0434  
0435      if (short_integra  
0436          corr=corr*exp  
0437              !taper the end to  
0438  
0439  
0440      !Interpolate cont  
0441      !Increasing inter  
0442      if (.false.) then  
0443          if (abs(sum(c  
0444          do j=1,4  
0445              call spli  
0446          end do  
0447          corr=0  
0448          llo=1  
0449          do l=lmin,lma
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 438

```
0438         if ((l > ls(llo+1))  
0439             llo=llo+1  
0440         end if  
0441         lhi=llo+1  
0442         ho=ls(lhi)-ls(llo)  
0443         a0=(ls(lhi)-1)/ho  
0444         b0=(l-ls(llo))/ho  
0445         fac1 = ho**2/6  
0446         fac2 = (b0**3-b0)*  
0447         fac1 = (a0**3-a0)*  
0448  
0449         corr(1) = Corr(1)+  
0450             fac1* ddcontribs(  
0451         corr(2) = Corr(2)+  
0452             fac1* ddcontribs(  
0453         corr(3) = Corr(3)+  
0454             fac1* ddcontribs(  
0455         corr(4) = Corr(4)+  
0456             fac1* ddcontribs(  
0457  
0458     end do  
0459 end if  
0460  
0461 !$ thread_ix = OMP_GET_THR  
0462  
0463 do l=lmin, lmax_lensed  
0464 !theta factors were pu  
0465  
0466  
0467 lens_contrib(C_Temp, l
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 450

```
0450         if ((l >  
0451             llo=1  
0452         end if  
0453         lhi=llo+1  
0454         ho=ls(lhi)  
0455         a0=(ls(lh  
0456         b0=(l-ls(  
0457         fac1 = ho  
0458         fac2 = (b  
0459         fac1 = (a  
0460  
0461         corr(1) =  
0462             fac1*  
0463         corr(2) =  
0464             fac1*  
0465         corr(3) =  
0466             fac1*  
0467         corr(4) =  
0468             fac1*  
0469  
0470     end do  
0471 end if  
0472  
0473 !$ thread_ix =  
0474  
0475  
0476  
0477  
0478  
0479 lens_contrib(
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 468

```
0468  
0469  
0470      T2 = corr(2)* d_22(1)  
0471      T4 = corr(3)* d_2m2(1)  
0472  
0473  
0474      lens_contrib(CT_E, 1,  
0475  
0476      lens_contrib(CT_B, 1,  
0477  
0478  
0479      lens_contrib(CT_Cross,  
0480  
0481  
0482      end do  
0483  
0484      end do  
0485 !$OMP END PARALLEL DO  
0486  
0487      do l=lmin, lmax_lensed  
0488          !sign from d(cos the  
0489          fac = l*(l+1)/OutputDe  
0490          Cl_lensed(l,in,CT_Temp  
0491              + Cl_scalar(  
0492          Cl_lensed(l,in,CT_E) =  
0493              + Cl_scalar(  
0494          Cl_lensed(l,in,CT_B) =  
0495          Cl_lensed(l,in,CT_Cros  
0496              + Cl_scalar(  
0497
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 480

```
0480      corr(1)*P  
0481  
0482  
0483  
0484  
0485  
0486  
0487  
0488  
0489  
0490  
0491  
0492  
0493  
0494  
0495  
0496  
0497  
0498  
0499  
0500  
0501  
0502  
0503  
0504  
0505  
0506  
0507  
0508  
0509  
      T2 = corr(2)*  
      T4 = corr(3)*  
      lens_contrib(  
          (T2+T4)*h  
      lens_contrib(  
          (T2-T4)*h  
      lens_contrib(  
          corr(4)*d  
      end do  
      end do  
      !$OMP END PARALLEL DO  
      do l=lmin, lmax_lense  
          !sign from d(cos  
          fac = l*(l+1)/Out  
          Cl_lensed(l,in,CT  
              + Cl_scalar(l  
          Cl_lensed(l,in,CT  
              + Cl_scalar(l  
          Cl_lensed(l,in,CT  
          Cl_lensed(l,in,CT  
              + Cl_scalar(l  
0509
```

/Users/lplopa/Compare/camb_simdata/lensing.f90, Top line: 498

```
0498      end do
0499
0500      end do !loop over difference
0501      deallocate(ddcontribs,cor)
0502      deallocate(lens_contrib)
0503
0504      if (DebugMsgs) write(*,*
0505
0506 end subroutine CorrFuncFullSk
0507
0508
0509
0510 subroutine CorrFuncFlatSky
0511 !Do flat sky approx partiall
0512   use ModelParams
0513   use ModelData
0514   use lvalues
0515   integer l, i
0516   integer :: npoints
0517   real(dl) Cgl2, sigmasq, th
0518   real(dl) dtheta
0519   real(dl) dbessfac, fac, fac
0520   real(sp) timeprev
0521   real(dl) Bessel0(lmin:CP%Ma)
0522   real(dl) Bessel4(lmin:CP%Ma)
0523   real(dl) Cphil3(lmin:CP%Max)
0524   integer max_lensed_ix
0525   integer b_lo
0526   integer in
0527   real(dl) T2,T4,a0, b0
```

/Users/lplopa/Compare/camb_des/lensing.f90, Top line: 510

```
0510      end do
0511
0512      end do !loop over difference
0513      deallocate(ddcontribs,cor)
0514      deallocate(lens_contrib)
0515
0516      if (DebugMsgs) write(*,*
0517
0518 end subroutine CorrFuncFu
0519
0520
0521
0522 subroutine CorrFuncFlatSk
0523 !Do flat sky approx parti
0524   use ModelParams
0525   use ModelData
0526   use lvalues
0527   integer l, i
0528   integer :: npoints
0529   real(dl) Cgl2, sigmasq,
0530   real(dl) dtheta
0531   real(dl) dbessfac, fac, f
0532   real(sp) timeprev
0533   real(dl) Bessel0(lmin:CP%
0534   real(dl) Bessel4(lmin:CP%
0535   real(dl) Cphil3(lmin:CP%M
0536   integer max_lensed_ix
0537   integer b_lo
0538   integer in
0539   real(dl) T2,T4,a0, b0
```

/Users/lplopa/Compare/camb_simdata/lensing.f90, Top line: 528

```
0528      real(dl) lfacs(CP%Max_1)
0529      real(dl), allocatable, dime
0530      integer thread_ix
0531      !$ integer OMP_GET_THREAD_NUM
0532      !$ external OMP_GET_THREAD_NUM
0533
0534      if (lensing_includes_tens
0535
0536      max_lensed_ix = 1Samp%10-
0537      do while(1Samp%1(max_lens
0538      max_lensed_ix = max_len
0539      end do
0540      lmax_lensed = 1Samp%1(max_
0541      if (allocated(Cl_lensed))
0542      allocate(Cl_lensed(lmin:1
0543
0544      Cl_Lensed = 0
0545
0546      npoints = CP%Max_1 * 2
0547      if (CP%AccurateBB) npoint
0548
0549      dtheta = pi / npoints
0550      if (.not. CP%AccurateBB)
0551      npoints = int(npoints / 3
0552      !OK for TT, EE, TE but
0553      !this induces high freq
0554      end if
0555
0556      call GetBessels(npoints*d
0557
```

/Users/lplopa/Compare/camb_des/lensing.f90, Top line: 540

```
0540      real(dl) lfacs(CP%Max_1)
0541      real(dl), allocatable, di
0542      integer thread_ix
0543      !$ integer OMP_GET_THREAD
0544      !$ external OMP_GET_THREA
0545
0546      if (lensing_includes_tens
0547
0548      max_lensed_ix = 1Samp%10-
0549      do while(1Samp%1(max_lens
0550      max_lensed_ix = max_1
0551      end do
0552      lmax_lensed = 1Samp%1(max_
0553      if (allocated(Cl_lensed))
0554      allocate(Cl_lensed(lmin:1
0555
0556      Cl_Lensed = 0
0557
0558      npoints = CP%Max_1 * 2
0559      if (CP%AccurateBB) npoint
0560
0561      dtheta = pi / npoints
0562      if (.not. CP%AccurateBB)
0563      npoints = int(npoints
0564      !OK for TT, EE, TE bu
0565      !this induces high fr
0566      end if
0567
0568      call GetBessels(npoints*d
0569
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 558

```
0558      if (DebugMsgs) timeprev=G
0559
0560      dbessfac = dbessel**2/6
0561
0562      thread_ix = 1
0563      !$ thread_ix = OMP_GET_MA
0564      allocate(lens_contrib(4,1
0565
0566      do in = 1, CP%InitPower%n
0567
0568      do l=lmin,CP%Max_l
0569          ! l^3 C_phi_phi/2/pi: Cl
0570          Cphil3(l) = Cl_scalar(
0571          fac = l/(2*pi)**2*pi/(l
0572          CTT(l) = Cl_scalar(l,
0573          CEE(l) = Cl_scalar(l,
0574          CTE(l) = Cl_scalar(l,
0575          lfacs(l) = l**2*0.5_dl
0576      end do
0577
0578      if (Cphil3(10) > 1e-7) th
0579          write (*,*) 'You need to
0580          write (*,*) 'see http://
0581          stop
0582      end if
0583
0584      lens_contrib=0
0585
0586      !$OMP PARALLEL DO DEFAULT(S
0587      !$OMP PRIVATE(theta, sigmas
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 570

```
0570      if (DebugMsgs) timeprev=G
0571
0572      dbessfac = dbessel**2/6
0573
0574      thread_ix = 1
0575      !$ thread_ix = OMP_GET_MA
0576      allocate(lens_contrib(4,1
0577
0578      do in = 1, CP%InitPower%n
0579
0580      do l=lmin,CP%Max_l
0581          ! l^3 C_phi_phi/2
0582          Cphil3(l) = Cl_sc
0583          fac = l/(2*pi)**2*
0584          CTT(l) = Cl_scal
0585          CEE(l) = Cl_scal
0586          CTE(l) = Cl_scal
0587          lfacs(l) = l**2*0
0588
0589
0590      if (Cphil3(10) > 1e-7)
0591          write (*,*) 'You
0592          write (*,*) 'see
0593          stop
0594      end if
0595
0596
0597
0598
0599      lens_contrib=0
0599
0599      !$OMP PARALLEL DO DEF
0599      !$OMP PRIVATE(theta,
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 588

```
0588 !$OMP PRIVATE(Bessel0,Besse  
0589 !$OMP PRIVATE(corr,expsig,C  
0590  
0591 do i=1,npoints-1  
0592  
0593     theta = i * dtheta  
0594     sigmasq =0  
0595     Cgl2=0  
0596     fac = theta /dbessel  
0597  
0598     do l=lmin,CP%Max_l  
0599  
0600 !Interpolate the Bessel funct  
0601     b0 = 1*fac  
0602     b_lo = int(b0) +1  
0603     a0= b_lo - b0  
0604     b0= 1._dl - a0  
0605     fac1 = a0*b0*dbessfac  
0606     fac2 = fac1*(a0-2)  
0607     fac1 = fac1*(b0-2)  
0608  
0609     Bessel0(l) = a0*Bess0  
0610             +fac2*  
0611     sigmasq = sigmasq + (
```

0612

0613

0614

0615

0616

0617

0618

0619

0620

0621

0622

0623

0624

0625

0626

0627

0628

0629

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 600

```
0600 !$OMP PRIVATE(Bessel0  
0601 !$OMP PRIVATE(corr,ex  
0602  
0603 do i=1,npoints-1  
0604  
0605     theta = i * dthet  
0606     sigmasq =0  
0607     Cgl2=0  
0608     fac = theta /dbes  
0609  
0610     do l=lmin,CP%Max_
```

```
0611  
0612 !Interpolate  
0613     b0 = 1*fac  
0614     b_lo = int(b0)  
0615     a0= b_lo - b0  
0616     b0= 1._dl -  
0617     fac1 = a0*b0*  
0618     fac2 = fac1*(  
0619     fac1 = fac1*(
```

```
0620  
0621     Bessel0(l) =  
0622             +fac2*ddB  
0623     sigmasq = sig
```

```
0624  
0625  
0626  
0627     Bessel2(l) =  
0628             +fac2*ddB  
0629     Cgl2 = Cgl2
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 618

```
0618      Bessel4(l) = a0*Bess4  
0619          +fac2*d  
0620      Bessel6(l) = a0*Bess6  
0621          +fac2*d  
0622  
0623      end do  
0624  
0625 !Get difference between lens  
0626     corr = 0  
0627     do l=lmin,CP%Max_l  
0628 !For 2nd order perturbative r  
0629 !     expsig = 1 -sigmasq  
0630 !     C2term = 1**2*Cg12/  
0631 !           fac = sigmasq*lfacs  
0632 !     expsig = exp(-fac)  
0633 !     C2term = Cg12*lfacs  
0634 !Put theta factor later in h  
0635     fac1 = expsig*theta  
0636     fac2 = C2term*fac1  
0637     fac1 = fac1 - theta  
0638  
0639     fac = fac1*Bessel0(  
0640  
0641 ! TT  
0642     corr(1) = corr(1) +  
0643  
0644 !Q + U  
0645     corr(2) = corr(2) +  
0646     fac2 = fac2*0.5_dl  
0647 !Q-U
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 630

```
0630  
0631  
0632  
0633  
0634  
0635  
0636  
0637 !Get difference b  
0638 corr = 0  
0639 do l=lmin,CP%Max_  
0640 !For 2nd orde  
0641 !     exp  
0642 !     C2t  
0643 fac = sigmasq  
0644 expsig = exp(  
0645 C2term = Cg12  
0646 !Put theta fa  
0647 fac1 = expsig  
0648 fac2 = C2term  
0649 fac1 = fac1 -  
0650  
0651 fac = fac1*Be  
0652  
0653 ! TT  
0654 corr(1) = cor  
0655  
0656  
0657  
0658  
0659 !Q-U
```

/Users/lplopa/Compare/camb_simdata/lensing.f90, Top line: 648

```
0648      corr(3) = corr(3) +  
0649          (fac1*Bessel4(l  
0650          !Cross  
0651          corr(4) = corr(4) +  
0652              (fac1*Bessel2(l  
0653  
0654  
0655      end do  
0656  
0657  
0658      !$ thread_ix = OMP_GET_THREADS  
0659  
0660      do l=lmin, lmax_lensed  
0661          !theta factors were pu  
0662          lens_contrib(C_Temp, l  
0663  
0664          T2 = corr(2)*Bessel0(l  
0665          T4 = corr(3)*Bessel4(l  
0666          lens_contrib(CT_E,l,th  
0667          lens_contrib(CT_B,l,th  
0668          lens_contrib(CT_Cross,  
0669  
0670      end do  
0671  
0672      end do  
0673      !$OMP END PARALLEL DO  
0674  
0675      do l=lmin, lmax_lensed  
0676          fac = l*(l+1)* 2*pi/Ou  
0677          Cl_lensed(l,in,CT_Temp
```

/Users/lplopa/Compare/camb_des/lensing.f90, Top line: 660

```
0660  
0661  
0662  
0663  
0664  
0665  
0666  
0667      !Cross  
0668  
0669      !$      thread_ix =  
0670      !$OMP  END PARALLEL DO  
0671  
0672      do l=lmin, lmax_l  
0673          !theta factor  
0674          lens_contrib(  
0675              corr(1)*B  
0676              T2 = corr(2)*  
0677              T4 = corr(3)*  
0678              lens_contrib(  
0679              lens_contrib(  
0680              lens_contrib(  
0681                  corr(4)*B  
0682      end do  
0683  
0684      end do  
0685      !$OMP END PARALLEL DO  
0686  
0687      do l=lmin, lmax_lense  
0688          fac = l*(l+1)* 2*  
0689          Cl_lensed(l,in,CT)
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 678

```
0678          + Cl_scalar(1  
0679          Cl_lensed(l,in,CT_Cros  
0680          +Cl_scalar(1  
0681          fac = fac /2 !(factor  
0682          Cl_lensed(l,in,CT_E) =  
0683          + Cl_scalar(1  
0684          Cl_lensed(l,in,CT_B) =  
0685        end do  
0686  
0687      end do !loop over differe  
0688      deallocate(lens_contrib)  
0689  
0690      if (DebugMsgs) write(*,*  
0691  
0692    end subroutine CorrFuncFlatSk  
0693  
0694    subroutine BadHarmonic  
0695      use ModelParams  
0696      use ModelData  
0697      use lvalues  
0698      use InitialPower  
0699      integer maxl, i, in, almin,  
0700      real(dl) , dimension (:,:,:,:  
0701      real(dl) pp(CP%InitPower%nn  
0702      real(dl) asum(CP%InitPower%  
0703      real(dl) asum_TE(CP%InitPow  
0704      integer l1,l2,al,j, j1, k,  
0705      real(dl) F, fct  
0706      real(dl) g21,g211, norm  
0707      real(dl) a3j(CP%Max_1*2+1),
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 690

```
0690          + Cl_scalar(1  
0691          Cl_lensed(l,in,CT  
0692          +Cl_scalar(1,  
0693          fac = fac /2 !(fa  
0694          Cl_lensed(l,in,CT  
0695          + Cl_scalar(1  
0696          Cl_lensed(l,in,CT  
0697        end do  
0698  
0699  
0700      deallocate(lens_contrib)  
0701  
0702      if (DebugMsgs) write(*,*  
0703  
0704    end subroutine CorrFuncFl  
0705  
0706    subroutine BadHarmonic  
0707      use ModelParams  
0708      use ModelData  
0709      use lvalues  
0710      use InitialPower  
0711      integer maxl, i, in, almi  
0712      real(dl) , dimension (:,:  
0713      real(dl) pp(CP%InitPower%  
0714      real(dl) asum(CP%InitPower%  
0715      real(dl) asum_TE(CP%InitP  
0716      integer l1,l2,al,j, j1, k,  
0717      real(dl) F, fct  
0718      real(dl) g21,g211, norm  
0719      real(dl) a3j(CP%Max_1*2+1),
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 708

```
0708 logical DoPol
0709 real(dl) iContribs(lSamp%10
0710 real(dl), dimension (:,:,:)
0711 integer max_j_contribs
0712
0713 real(sp) timeprev
0714
0715 !Otherwise use second order p
0716
0717 if (DebugMsgs) timeprev=Get
0718
0719 DoPol = CP%AccuratePolariza
0720
0721 maxl = CP%Max_l
0722
0723 if (allocated(Cl_lensed)) d
0724
0725
0726 allocate(bare_cls(CP%InitPo
0727
0728 RR = 0
0729 do j=lmin,maxl
0730     norm = OutputDenominator
0731     if (lensing_includes_ten
0732         bare_cls(:,j,CT_Temp:CT
0733             Cl_tensor(j,:,CT_T
0734             bare_cls(:,j,CT_B) = Cl
0735             bare_cls(:,j,CT_Cross)
0736                 Cl_tensor(j,:,CT_Cr
0737 else
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 720

```
0720 logical DoPol
0721 real(dl) iContribs(lSamp%
0722 real(dl), dimension (:,:)
0723 integer max_j_contribs
0724
0725 real(sp) timeprev
0726
0727 !Otherwise use second ord
0728
0729 if (DebugMsgs) timeprev=G
0730
0731 DoPol = CP%AccuratePolariz
0732
0733 maxl = CP%Max_l
0734
0735 if (allocated(Cl_lensed))
0736
0737
0738 allocate(bare_cls(CP%Init
0739
0740 RR = 0
0741 do j=lmin,maxl
0742     norm = OutputDenomina
0743     if (lensing_includes_
0744         bare_cls(:,j,CT_T
0745             Cl_tensor(j,:,
0746             bare_cls(:,j,CT_B
0747             bare_cls(:,j,CT_C
0748                 Cl_tensor(j,:,
0749 else
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 738

```
0738      bare_cls(:,j,CT_Temp:CT
0739      bare_cls(:,j,CT_B) = 0
0740      bare_cls(:,j,CT_Cross)
0741      end if
0742      pp(:,j) = Cl_scalar(j,:,
0743      RR = RR + j*(j+1)*real(2
0744      roots(j) = sqrt(real(2*j
0745      end do
0746
0747      RR = RR/2/fourpi
0748      if (RR(1) > 1e-5) then
0749          write (*,*) 'You need to
0750          write (*,*) 'see http://
0751          stop
0752      end if
0753      if (maxl > lmax_donelnfa) t
0754          !Get ln factorials
0755          if (allocated(lnfa)) deallo
0756          allocate(lnfa(0:maxl*3+1))
0757          lmax_donelnfa = maxl
0758          lnfa(0) = 0
0759          do i=1,CP%Max_l*3+1
0760              lnfa(i)=lnfa(i-1) + log(
0761          end do
0762      end if
0763
0764      max_lensed_ix = 1Samp%10-1
0765      do while(1Samp%1(max_lensed
0766          max_lensed_ix = max_lens
0767      end do
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 750

```
0750      bare_cls(:,j,CT_T
0751      bare_cls(:,j,CT_B
0752      bare_cls(:,j,CT_C
0753      end if
0754      pp(:,j) = Cl_scalar(j
0755      RR = RR + j*(j+1)*rea
0756      roots(j) = sqrt(real(
0757      end do
0758
0759      RR = RR/2/fourpi
0760      if (RR(1) > 1e-5) then
0761          write (*,*) 'You need
0762          write (*,*) 'see http
0763          call MPIStop()
0764      end if
0765      if (maxl > lmax_donelnfa)
0766          !Get ln factorials
0767          if (allocated(lnfa))
0768          allocate(lnfa(0:maxl*
0769          lmax_donelnfa = maxl
0770          lnfa(0) = 0
0771          do i=1,CP%Max_l*3+1
0772              lnfa(i)=lnfa(i-1)
0773          end do
0774
0775
0776      max_lensed_ix = 1Samp%10-
0777      do while(1Samp%1(max_lens
0778          max_lensed_ix = max_l
0779      end do
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 768

```
0768 lmax_lensed = 1Samp%l(max_l  
0769  
0770 allocate(iCl_lensed(max_len  
0771  
0772 max_j_contribs = 1Samp%10-1  
0773 if (.not. DoPol) then  
0774     maxl_phi = min(max  
0775     do while (1Samp%l(  
0776         max_j_contribs=  
0777         end do  
0778     end if  
0779  
0780 !$OMP PARALLEL DO DEFAULT(S  
0781 !$OMP PRIVATE(al,g1,llp_al,  
0782 !$OMP PRIVATE(asum_EE,asum_  
0783 do j=max_lensed_ix,1,-1  
0784     !Only compute lensed spe  
0785  
0786     al=1Samp%l(j)  
0787  
0788     llp_al = al*(al+1)  
0789     g2l=sqrt((2*al+1)/fourpi  
0790  
0791     asum = 0  
0792     asum_EE = 0  
0793     asum_BB = 0  
0794     asum_TE = 0  
0795  
0796     do j1 = 1, max_j_contrib  
0797
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 780

```
0780 lmax_lensed = 1Samp%l(max  
0781  
0782 allocate(iCl_lensed(max_l  
0783  
0784 max_j_contribs = 1Samp%10  
0785 if (.not. DoPol) then  
0786     maxl_phi = min(maxl,n  
0787     do while (1Samp%l(max  
0788         max_j_contribs=ma  
0789         end do  
0790     end if  
0791  
0792 !$OMP PARALLEL DO DEFAULT  
0793 !$OMP PRIVATE(al,g1,llp_a  
0794 !$OMP PRIVATE(asum_EE,asu  
0795 do j=max_lensed_ix,1,-1  
0796     !Only compute lensed  
0797  
0798     al=1Samp%l(j)  
0799  
0800     llp_al = al*(al+1)  
0801     g2l=sqrt((2*al+1)/fou  
0802  
0803     asum = 0  
0804     asum_EE = 0  
0805     asum_BB = 0  
0806     asum_TE = 0  
0807  
0808     do j1 = 1, max_j_cont  
0809
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 798

```
0798      ! Contributions to C  
0799      l1=lSamp%l(j1)  
0800  
0801      llp_1 = l1*(l1+1)  
0802      g2ll=roots(l1)  
0803  
0804      almin = max(abs(al-l1  
0805  
0806      if (DoPol) then  
0807          call GetThreeJs(a3j)  
0808          do l2= almin, min(m  
0809              g1 = llp_1+l2*(  
0810              if (g1 == 0 ) c  
0811  
0812              k=al+l1+l2  
0813              fct=g1*g21*g211  
0814              tF = fct*a3j(l2  
0815  
0816      if (mod(k,2)==0  
0817  
0818          hk = k/2  
0819          F = lnfa(hk)  
0820          & +lnfa(k-2  
0821  
0822          expF = exp(F  
0823  
0824          asum=asum +  
0825  
0826          asum_EE = as  
0827          asum_BB = as
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 810

```
0810      ! Contributions  
0811      l1=lSamp%l(j1)  
0812  
0813  
0814  
0815  
0816  
0817  
0818  
0819  
0820  
0821  
0822  
0823  
0824  
0825  
0826  
0827  
0828  
0829  
0830  
0831  
0832  
0833  
0834  
0835  
0836  
0837  
0838  
0839
```

/Users/lplopa/Compare/camb_simdata/lensing.f90, Top line: 828

```
0828      if (mod(hk,2
0829      asum_TE = as
0830
0831      else
0832      [REDACTED]
0833      asum_BB = as
0834      asum_EE = as
0835
0836      end if
0837      [REDACTED]
0838      end do
0839
0840      else !No polarization
0841      do 12= almin +mod(a
0842      !Only do 1Samp%1
0843      [REDACTED]
0844      g1 = llp_1+12*(
0845      [REDACTED]
0846      if (g1 == 0 ) c
0847
0848      k=al+11+12
0849      hk=k/2
0850      [REDACTED]
0851      fct=g1*g21*g211
0852      expF = exp(2*(1
0853          & +lnfa(k-2
0854      asum=asum + bar
0855      [REDACTED]
0856      end do
0857      end if !No polariza
```

/Users/lplopa/Compare/camb_des/lensing.f90, Top line: 840

```
0840 if (m
0841 asum_
0842
0843 else
0844
0845 asum_
0846 asum_
0847
0848 end if
0849
0850 end do
0851
0852 else !No polariza
0853 do 12= almin
0854 !Only do
0855
0856 g1 = l1p_
0857
0858 if (g1 ==
0859
0860 k=al+l1+l1
0861 hk=k/2
0862
0863 fct=g1*g2
0864 expF = ex
0865 & +ln
0866 asum=asum
0867
0868 end do
0869 end if !No polari
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 858

```
0858  
0859  
0860      iContribs(j1,:,:)C  
0861      if (DoPol) then  
0862          iContribs(j1,  
0863          iContribs(j1,  
0864          iContribs(j1,  
0865      end if  
0866      asum = 0  
0867      asum_EE = 0  
0868      asum_BB = 0  
0869      asum_TE = 0  
0870  
0871      end do  
0872  
0873      !Interpolate contribut  
0874      do in=1, CP%InitPower  
0875  
0876          call InterpolateC  
0877          asum(in) = sum(in  
0878          if (DoPol) then  
0879              call Interpol  
0880              asum_EE(in) =  
0881              call Interpol  
0882              asum_BB(in) =  
0883              call Interpol  
0884              asum_TE(in) =  
0885          end if  
0886  
0887
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 870

```
0870  
0871  
0872      iContribs(j1,:,:)CT  
0873      if (DoPol) then  
0874          iContribs(j1,  
0875          iContribs(j1,  
0876          iContribs(j1,  
0877      end if  
0878      asum = 0  
0879      asum_EE = 0  
0880      asum_BB = 0  
0881      asum_TE = 0  
0882  
0883      end do  
0884  
0885  
0886      !Interpolate contribu  
0887      do in=1, CP%InitPower  
0888          call InterpolateC  
0889          asum(in) = sum(in  
0890          if (DoPol) then  
0891              call Interpol  
0892              asum_EE(in) =  
0893              call Interpol  
0894              asum_BB(in) =  
0895              call Interpol  
0896              asum_TE(in) =  
0897          end if  
0898  
0899
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 888

```
0888      end do
0889
0890      iCl_lensed(j,:,:,CT_Temp)
0891          + asum/(2*al+1)
0892      if (DoPol) then
0893          iCl_lensed(j,:,:,CT_E)
0894              + asum_EE/(2*al
0895          iCl_lensed(j,:,:,CT_B)
0896              + asum_BB/(2*al
0897          iCl_lensed(j,:,:,CT_Cro
0898              + asum_TE/(2*
0899
0900      else
0901          iCl_lensed(j,:,:,CT_E:C
0902      end if
0903
0904      end do
0905 !$OMP END PARALLEL DO
0906
0907 deallocate(bare_cls)
0908
0909 allocate(Cl_lensed(lmin:lma
0910
0911 !Interpolate to get final s
0912 do in=1, CP%InitPower%nn
0913     do j = CT_Temp, CT_Cross
0914         call InterpolateClArr(l
0915     end do
0916 end do
0917
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 900

```
0900      end do
0901
0902      iCl_lensed(j,:,:,CT_Tem
0903          + asum/(2*al+1))*_
0904      if (DoPol) then
0905          iCl_lensed(j,:,:,CT_E)
0906              + asum_EE/(2*
0907          iCl_lensed(j,:,:,CT_B)
0908              + asum_BB/(2*
0909          iCl_lensed(j,:,:,CT_Cro
0910              + asum_TE/(2*
0911
0912      else
0913          iCl_lensed(j,:,:,CT_E:C
0914      end if
0915
0916      end do
0917 !$OMP END PARALLEL DO
0918
0919 deallocate(bare_cls)
0920
0921 allocate(Cl_lensed(lmin:lma
0922
0923 !Interpolate to get final s
0924 do in=1, CP%InitPower%nn
0925     do j = CT_Temp, CT_Cr
0926         call InterpolateC
0927     end do
0928 end do
0929
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 918

```
0918      deallocate(icl_lensed)
0919
0920      if (DebugMsgs) then
0921          if (FeedbackLevel>0)
0922      end if
0923
0924      end subroutine BadHarmonic
0925
0926      subroutine GetBessels(M
0927          real(dl), intent(in):::
0928              integer i
0929          real(dl), allocatable,
0930              integer max_bes_ix
0931          integer, save :: last_
0932
0933          max_bes_ix = nint(MaxA
0934          if (max_bes_ix > last_
0935              last_max = max_bes_ix
0936              if (allocated(Bess0))
0937                  deallocate(Bess0)
0938                  deallocate(Bess2)
0939                  deallocate(Bess4)
0940                  deallocate(Bess6)
0941              end if
0942              allocate(Bess0(max_bes_ix)
0943
0944              allocate(Bess2(max_bes_ix)
0945              allocate(Bess4(max_bes_ix)
0946              allocate(Bess6(max_bes_ix)
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 930

```
0930      deallocate(icl_lensed)
0931
0932      if (DebugMsgs) then
0933          if (FeedbackLevel>0)
0934      end if
0935
0936      end subroutine BadHarmonic
0937
0938      subroutine GetBessels(Max
0939          real(dl), intent(in):: Ma
0940              integer i
0941          real(dl), allocatable, di
0942              integer max_bes_ix
0943          integer, save :: last_max
0944
0945          max_bes_ix = nint(MaxArg
0946          if (max_bes_ix > last_max
0947              last_max = max_bes_ix
0948              if (allocated(Bess0))
0949                  deallocate(Bess0,
0950                  deallocate(Bess2,
0951                  deallocate(Bess4,
0952                  deallocate(Bess6,
0953              end if
0954              allocate(Bess0(max_be
0955
0956              allocate(Bess2(max_be
0957              allocate(Bess4(max_be
0958              allocate(Bess6(max_be
0959
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 947

```
0947      allocate(x(max_bes
0948      Bess0(1)=1
0949      Bess2(1)=0; Bess4(
0950      x(1)=0
0951      do i=2, max_bes_ix
0952          x(i) = (i-1)*dbe
0953          Bess0(i) = Bessj
0954          Bess2(i) = Bessj
0955          Bess4(i) = Bessj
0956          Bess6(i) = Bessj
0957      end do
0958      call spline(x,Bess
0959      call spline(x,Bess
0960      call spline(x,Bess
0961      call spline(x,Bess
0962
0963      deallocate(x)
0964  end if
0965
0966  end subroutine GetBesse
0967
0968 !Wrap standard built-in F2008
0969
0970      FUNCTION bessj0(x)
0971      real(dl) bessj0,x
0972
0973      bessj0 = bessel_j0(x)
0974
0975      END FUNCTION bessj0
0976
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 960

```
0960      allocate(x(max_bes_ix
0961      Bess0(1)=1
0962      Bess2(1)=0; Bess4(1)=
0963      x(1)=0
0964      do i=2, max_bes_ix
0965          x(i) = (i-1)*dbes
0966          Bess0(i) = Bessj0
0967          Bess2(i) = Bessj(
0968          Bess4(i) = Bessj(
0969          Bess6(i) = Bessj(
0970      end do
0971      call spline(x,Bess0,m
0972      call spline(x,Bess2,m
0973      call spline(x,Bess4,m
0974      call spline(x,Bess6,m
0975
0976      deallocate(x)
0977  end if
0978
0979
0980
0981
0982
0983
0984
0985
0986
0987
0988
0989
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 977

```
0977      FUNCTION bessj(n,x)
0978      real(dl) bessj,x
0979      integer n
0980
0981      bessj = bessel_jn(n,x)
0982
0983      END FUNCTION bessj
0984
0985 ! -----
0986 ! Auxiliary Bessel functions
0987      FUNCTION BESSIO(X)
0988      double precision X,BESS
0989      Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8
0990      DATA P1,P2,P3,P4,P5,P6,
0991      0.2659732D0,0.360768D-1
0992      DATA Q1,Q2,Q3,Q4,Q5,Q6,
0993      0.225319D-2,-0.157565D-
0994      0.2635537D-1,-0.1647633
0995      IF(ABS(X).LT.3.75D0) TH
0996      Y=(X/3.75D0)**2
0997      BESSIO=P1+Y*(P2+Y*(P3+Y
0998      ELSE
0999      AX=ABS(X)
1000      Y=3.75D0/AX
1001      BX=EXP(AX)/SQRT(AX)
1002      AX=Q1+Y*(Q2+Y*(Q3+Y*(Q4
1003      BESSIO=AX*BX
1004      ENDIF
1005      RETURN
1006      END FUNCTION BESSIO
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 990

```
0990      FUNCTION bessj(n,x)
0991      real(dl) bessj,x
0992      integer n
0993
0994      bessj = bessel_jn(n,x)
0995
0996      END FUNCTION bessj
0997
0998 ! -----
0999 ! Auxiliary Bessel functi
1000      FUNCTION BESSIO(X)
1001      double precision X,BESSIO
1002      Q1,Q2,Q3,Q4,Q5,Q6,Q7,
1003      DATA P1,P2,P3,P4,P5,P6,P7
1004      0.2659732D0,0.360768D
1005      DATA Q1,Q2,Q3,Q4,Q5,Q6,Q7
1006      0.225319D-2,-0.157565
1007      0.2635537D-1,-0.16476
1008      IF(ABS(X).LT.3.75D0) THEN
1009      Y=(X/3.75D0)**2
1010      BESSIO=P1+Y*(P2+Y*(P3+
1011      ELSE
1012      AX=ABS(X)
1013      Y=3.75D0/AX
1014      BX=EXP(AX)/SQRT(AX)
1015      AX=Q1+Y*(Q2+Y*(Q3+Y*(Q4
1016      BESSIO=AX*BX
1017      ENDIF
1018      RETURN
1019      END FUNCTION BESSIO
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 1007

```
1007 ! -----
1008      FUNCTION BESSI1(X)
1009      double precision X,BESS
1010      Q1,Q2,Q3,Q4,Q5,Q6,Q7,Q8
1011      DATA P1,P2,P3,P4,P5,P6,
1012      0.15084934D0,0.2658733D
1013      DATA Q1,Q2,Q3,Q4,Q5,Q6,
1014      -0.362018D-2,0.163801D-
1015      -0.2895312D-1,0.1787654
1016      IF(ABS(X).LT.3.75D0) TH
1017      Y=(X/3.75D0)**2
1018      BESSI1=X*(P1+Y*(P2+Y*(P
1019      ELSE
1020      AX=ABS(X)
1021      Y=3.75D0/AX
1022      BX=EXP(AX)/SQRT(AX)
1023      AX=Q1+Y*(Q2+Y*(Q3+Y*(Q4
1024      BESSI1=AX*BX
1025      ENDIF
1026      RETURN
1027      END FUNCTION BESSI1
1028
1029
1030      FUNCTION BESSI(N,X)
1031      !from http://perso.oran
1032      !
1033      ! This subroutine calcul
1034      ! of integer order N, for
1035      ! recursion formula, when
1036      ! is used to avoid overfl
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 1020

```
1020 ! -----
1021      FUNCTION BESSI1(X)
1022      double precision X,BESSI1
1023      Q1,Q2,Q3,Q4,Q5,Q6,Q7,
1024      DATA P1,P2,P3,P4,P5,P6,P7
1025      0.15084934D0,0.265873
1026      DATA Q1,Q2,Q3,Q4,Q5,Q6,Q7
1027      -0.362018D-2,0.163801
1028      -0.2895312D-1,0.17876
1029      IF(ABS(X).LT.3.75D0) THEN
1030      Y=(X/3.75D0)**2
1031      BESSI1=X*(P1+Y*(P2+Y*
1032      ELSE
1033      AX=ABS(X)
1034      Y=3.75D0/AX
1035      BX=EXP(AX)/SQRT(AX)
1036      AX=Q1+Y*(Q2+Y*(Q3+Y*(
1037      BESSI1=AX*BX
1038      ENDIF
1039      RETURN
1040      END FUNCTION BESSI1
1041
1042
1043      FUNCTION BESSI(N,X)
1044      !from http://perso.orange
1045      !
1046      ! This subroutine cal
1047      ! of integer order N,
1048      ! recursion formula,
1049      ! is used to avoid ov
```

/Users/lp1opa/Compare/camb_simdata/lensing.f90, Top line: 1037

```
1037      !      REFERENCE:  
1038      !      C.W.CLENSHAW, CHEBYSHEV  
1039      !      MATHEMATICAL TABLES, VO  
1040      integer, intent(in) ::  
1041      integer, PARAMETER :: I  
1042      integer m,j  
1043      double precision, param  
1044      double precision X,BESS  
1045      IF (N.EQ.0) THEN  
1046      BESSI = BESSIO(X)  
1047      RETURN  
1048      ENDIF  
1049      IF (N.EQ.1) THEN  
1050      BESSI = BESSI1(X)  
1051      RETURN  
1052      ENDIF  
1053      IF(X.EQ.0.D0) THEN  
1054      BESSI=0.D0  
1055      RETURN  
1056      ENDIF  
1057      TOX = 2.D0/X  
1058      BIP = 0.D0  
1059      BI = 1.D0  
1060      BESSI = 0.D0  
1061      M = 2*((N+INT(SQRT(FLOA  
1062      DO J = M,1,-1  
1063      BIM = BIP+ J*TOX*BI  
1064      BIP = BI  
1065      BI = BIM  
1066      IF (ABS(BI).GT.BIGNO) T 1079
```

/Users/lp1opa/Compare/camb_des/lensing.f90, Top line: 1050

```
1050      !      REFERENCE:  
1051      !      C.W.CLENSHAW, CHEBY  
1052      !      MATHEMATICAL TABLES  
1053      integer, intent(in) :: N  
1054      integer, PARAMETER :: IAC  
1055      integer m,j  
1056      double precision, paramet  
1057      double precision X,BESSI,  
1058      IF (N.EQ.0) THEN  
1059      BESSI = BESSIO(X)  
1060      RETURN  
1061      ENDIF  
1062      IF (N.EQ.1) THEN  
1063      BESSI = BESSI1(X)  
1064      RETURN  
1065      ENDIF  
1066      IF(X.EQ.0.D0) THEN  
1067      BESSI=0.D0  
1068      RETURN  
1069      ENDIF  
1070      TOX = 2.D0/X  
1071      BIP = 0.D0  
1072      BI = 1.D0  
1073      BESSI = 0.D0  
1074      M = 2*((N+INT(SQRT(FLOAT(  
1075      DO J = M,1,-1  
1076      BIM = BIP+ J*TOX*BI  
1077      BIP = BI  
1078      BI = BIM  
1079      IF (ABS(BI).GT.BIGNO)
```

/Users/lp1lopa/Compare/camb_simdata/lensing.f90, Top line: 1067

```
1067      BI = BI*BIGNI
1068      BIP = BIP*BIGNI
1069      BESSI = BESSI*BIGNI
1070      ENDIF
1071      IF (J.EQ.N) BESSI = BIP
1072      END DO
1073      BESSI = BESSI*BESSIO(X)
1074      RETURN
1075      END FUNCTION BESSI
1076
1077
1078      end module lensing
1079
1080
```

/Users/lp1lopa/Compare/camb_des/lensing.f90, Top line: 1080

```
1080      BI = BI*BIGNI
1081      BIP = BIP*BIGNI
1082      BESSI = BESSI*BIG
1083      ENDIF
1084      IF (J.EQ.N) BESSI = B
1085      END DO
1086      BESSI = BESSI*BESSIO(X)/B
1087      RETURN
1088      END FUNCTION BESSI
1089
1090
1091      end module lensing
1092
1093
```