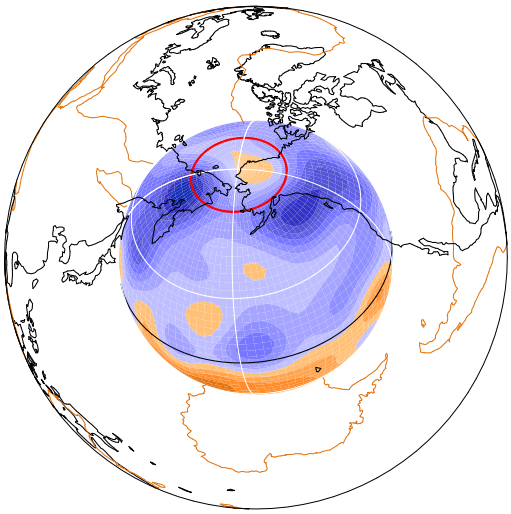
LEOPACK



svenspec

Solution **V**ector **EN**ergy **SPEC**trum

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1 svenspec

Solution **V**ector **EN**ergy **SPEC**trum

Reads in a solution vector in standard form (i.e. with a `.ints`, `.vecs` and `.xarr` file) and produces somewhat miscellaneous data on the spherical integrals of kinetic and magnetic energies of the solution.

The stand-alone source code version of the program is compiled by typing

```
make svenspec
```

within this directory. Once the executable is created, begin execution by typing

```
svenspec < inputfile
```

The inputs file must have the following format.

```
../../EXAMPLES/FUNDAMENTALS/case1.ints
../../EXAMPLES/FUNDAMENTALS/case1.xarr
../../EXAMPLES/FUNDAMENTALS/case1.vecs
example_aOUTPUT
```

Note that, unlike the input files to many of the other programs, an asterisk (`*`) can **NOT** be used to "comment out" any part of the input file. Neither can comments be inserted after the variables on each line. The input file must therefore be exactly as the form given.

The arguments are as follows

- `LINE ONE`: name of already existing indices file describing a solution vector. (i.e. a `.ints` file).
- `LINE TWO`: name of already existing radial spacings file describing solution. (i.e. a `.xarr` file).
- `LINE THREE`: name of already existing vector file describing solution. Must contain the same number of radial functions as indicated in the `.ints` file and the same number of radial grid nodes as indicated in the `.xarr` file.
- `LINE FOUR`: Name of output file.

1.1 Subprograms required for svenspec

SUBS subroutines

```
vecop.f matop.f hmfrd.f xarrrd.f svfrd.f svfdcf.f
shkeer.f fopen.f fclose.f ldgnmf.f gfdcfd.f asvdr.f
fnamer.f
```

SUBS double precision function

```
emmult.f sqrll1.f
```

SUBS integer function

```
indshc.f indfun.f
```

BLAS integer function

```
idamax.f
```

BLAS subroutines

```
dgemm.f dtrsm.f dgemv.f dswap.f dger.f  dscal.f
dtrmm.f dtrmv.f
```

LAPACK subroutines

```
dgetrf.f dgetri.f dgetf2.f dlaswp.f xerbla.f dtrtri.f
dtrti2.f
```

LAPACK integer function

```
ilaenv.f
```

LAPACK logical function

```
lsame.f
```

1.2 Run-time limitations

Several parameters are set at the outset which limit the physical size of the problem.

```
 INTEGER NRMAX, NHMAX, NDCS, LHMAX, NBN, NCFM, LHLH2M
 PARAMETER ( NRMAX = 200, NHMAX = 5000, LHMAX = 156,
1            NDCS = LHMAX + 4, NBN = 3, NCFM = 2*NBN + 1,
2            LHLH2M = LHMAX*(LHMAX+2)  )
```

If the values are insufficient, then change them and recompile.

- `NRMAX` is the maximum number of radial grid nodes allowed.
- `NHMAX` is the maximum number of spherical harmonic radial functions allowed.
- `LHMAX` is the highest permitted spherical harmonic degree, l.
- `NBN` is the number of bounding nodes on either side of the finite difference stencil. `NBN = 3` is recommended value.

1.3 Outputs from SVENSPEC

The file whose name is specified on the fourth line of the input file has the first 8 lines as follows:

```
LINE 1:Poloidal kinetic energy   =          164.204596
LINE 2:Toroidal kinetic energy   =          275.099295
LINE 3:Total kinetic energy      =          439.303891
LINE 4:Poloidal magnetic energy  =           26.878899
LINE 5:Toroidal magnetic energy  =           18.156107
LINE 6:Total magnetic energy     =           45.035007
LINE 7:Scaled kinetic energy     =           30.091780
LINE 8:Scaled magnetic energy    =            3.084843
```

The variables output are as follows:-

1. $K_{\rm P} = 0.5 \int_{\rm Vol} [\boldsymbol{u}_{\rm P}]^2 \, dV$ where $\boldsymbol{u}_{\rm P}$ is the poloidal velocity
2. $K_{\rm T} = 0.5 \int_{\rm Vol} [\boldsymbol{u}_{\rm T}]^2 \, dV$ where $\boldsymbol{u}_{\rm T}$ is the toroidal velocity
3. $K = K_{\rm P} + K_{\rm T}$.
4. $M_{\rm P} = 0.5 \int_{\rm Vol} [\boldsymbol{B}_{\rm P}]^2 \, dV$ where $\boldsymbol{B}_{\rm P}$ is the poloidal magnetic field
5. $M_{\rm T} = 0.5 \int_{\rm Vol} [\boldsymbol{B}_{\rm T}]^2 \, dV$ where $\boldsymbol{B}_{\rm T}$ is the toroidal magnetic field
6. $M = M_{\rm P} + M_{\rm T}$.
7. K/Vol..
8. M/Vol..

Following this, a series of lines are written

```
L=      1   0.0000000D+00   2.7267820D+01   2.1497321D+01   0.0000000D+00
L=      2   4.4378594D-01   0.0000000D+00   0.0000000D+00   3.2058448D+00
 etc.
```

After the specification of spherical harmonic degree, l, the four numbers given are, from the left,

1. $K_{\rm P}$ as above, but with velocity $\boldsymbol{u}$ restricted to poloidal harmonics of degree l only.
2. $K_{\rm T}$ as above, but with velocity $\boldsymbol{u}$ restricted to toroidal harmonics of degree l only.
3. $M_{\rm P}$ as above, but with magnetic field $\boldsymbol{B}$ restricted to poloidal harmonics of degree l only.
4. $M_{\rm T}$ as above, but with magnetic field $\boldsymbol{B}$ restricted to toroidal harmonics of degree l only.

Following this, a series of lines are written

```
M=      0   1.5550156D+00   3.6112105D+01   2.3689472D+01   9.9976062D+00
M=      4   1.4610767D+02   2.2203166D+02   2.3194027D+00   7.1619426D+00
 etc.
```

After the specification of spherical harmonic order, m, the four numbers given are, from the left,

1. $K_{\rm P}$ as above, but with velocity $\boldsymbol{u}$ restricted to poloidal harmonics of order m only.
2. $K_{\rm T}$ as above, but with velocity $\boldsymbol{u}$ restricted to toroidal harmonics of order m only.
3. $M_{\rm P}$ as above, but with magnetic field $\boldsymbol{B}$ restricted to poloidal harmonics of order m only.
4. $M_{\rm T}$ as above, but with magnetic field $\boldsymbol{B}$ restricted to toroidal harmonics of order m only.

1.4 Sample runs of svenspec

The directory

`$LEOPACK_DIR/SAMPLERUNS/SVENSPEC`

contains example input files and model output. Do not under any circumstances edit these files, as these examples should serve as a control for the correct working of the code. After compiling the program, copy the `.input` files to another directory, run the code and confirm that the output agrees with that in the directory.

1.4.1 Example a

We calculate the energy spectrum of the solution described by the 3 files

```
$LEOPACK_DIR/EXAMPLES/FUNDAMENTALS/case1.ints
$LEOPACK_DIR/EXAMPLES/FUNDAMENTALS/case1.vecs
$LEOPACK_DIR/EXAMPLES/FUNDAMENTALS/case1.xarr
```

References