Guide to Start with SPARVM
Updated 17 September 2012

A. Pre-Install SPARVM

See pre_install_sparvm to install SPICE and ASTROLIB necessary to run SPARVM

B. Installing SPARVM

1. Save sparvm.tar.gz to your desired destination
2. Unzip and Untar

   tar -zxvf sparvm.tar.gz

3. Put sparvm/IDL in IDL path

   i. If using IDLDE (this might vary depending on IDL version used)

   Click on "Window" → "Preference" → "IDL" → "Paths" → "Insert" →

   Guide it to the sparvm/IDL folder → "OK" → "Check the square box

   (this means look at the subfolder)" → "Apply" → "OK"

   ii. If using IDL (have to do every session)

   !PATH=!PATH+':'+Expand_Path('+~/path_to_sparvm/IDL')

   iii. You can simply copy and paste all the *.pro files from sparvm/IDL to your IDL working directory. All sparvm IDL routines start with "sparvm_" to avoid any confusion.

4. Test if SPARVM is installed properly by running :

   IDL> .compile sparvm_getinfo_station
   IDL> sparvm_getinfo_station, 'ICC2', st_info
   IDL> print, 'ICC2 Lat [deg], Lon [deg], Alt [m]=', st_info

   Should Print →
   ICC2 Lat [deg], Lon [deg], Alt [m]= -17.823333 122.62361 50.000000

5. Most of the sparvm routines were re-written to make it more robust, systematic, and understandable by third party. Rigorous testing has not been performed, so please use the software with caution.

C. Understanding SPARVM using Metrec data

1. ICC2 and LCC3 folder contains metrec data of meteors from 2001 Leonids observation from Australia.

2. The station information (Latitude, Longitude, Altitude) are saved in sparvm_getinfo_station.pro.

3. sparvm_configuration.pro contains all configuration details for sparvm software :

   i. Modify paths to SPICE (path_to_spice_kernels)
   ii. Modify path of input data folders (inputfolder1 & inputfolder2)
   iii. Modify path of LOG file (logfile_path)

4. Check that sparvm/spice/kernels/standard.ker contains full path to 4 kernel files in the same folder.

5. Compile and run sparvm_double_station_main.pro. This is the main routine which calls all other sparvm routines.

6. Check if the output files have been created at LCC3 and ICC2/filename_sparvm.OUT

7. Check if the LOG file has been created at logfile_path/sparvm_ddmmyyyy_hhmmss.LOG

8. Change inputfolders in file sparvm_test_leonids.pro and compile and run. Check the output as below:

Total number of leonid meteors	*42*	
Leonids radiant RA and std [deg]	*154.02*	*2.1*
Leonids radiant Dec and std [deg]	*20.98*	*1.2*
Velocity Infinity from station-1 and std [km/s]	*72.60*	*16.5*
Velocity Infinity from station-2 and std [km/s]	*75.40*	*23.0*

9. Note: The velocity obtained for Leonids is higher than theoretical value of 71 km/s. However, it is within the error, and the large error is due to the quality of the data as well.

10. This result will confirm that all sparvm routine is working similarly to developers machine.

11. If possible please check sparvm with other available software to compare results. Some of the method used in sparvm might not be best choice for your data, or simply, can have errors or bugs.

D. List of changes for integrating SPARVM for your meteor data

1. Complete Section-C to make sure that all sparvm routines work. The changes mentioned in Section C are not repeated here.

2. Edit sparvm_getinfo_station.pro. Add *Latitude*, *Longitude* and *Altitude* of your stations to *dfn_st1* and *dfn_st2* keywords. Modify *dfn_st1* and *dfn_st2* to your station names

3. Edit sparvm_configuration.pro

   i. Change *station1_code* and *station2_code* to match with D2.

   ii. Change *inputfolder1* and *inputfolder2* to paths where your data is stored.

   iii. Change *inputfile_extension* to your input file name.

   iv. It is assumed that all meteor data files are under one folder/directory. If you know the number of sub-folders tree you can include them using '/*/*' in inputfolder1 as

   inputfolder1 = '/home/atreya/IDLWorkspace71/ICC2//*/*'*

   v. Modify logfile_path to your appropriate path.

4. Edit sparvm_file_time.pro. This routine reads time from file name and uses this time to check if there are any double station meteors. If two meteors have time difference of less than *meteor_diff* , set in sparvm_configuration.pro, then they are considered double station. Please see the 'Note' section in sparvm_file_time.pro on how to modify for alternative file names. You can also write your own routine to read time. The time of all files are saved in *timehr1* and *timehr2* array, and can have different size.

5. Edit sparvm_read_metrec.pro. Create another routine to read your data output file. The input needed for sparvm software are RA, Dec and Julain Day. Replace sparvm_read_metrec by your routine in the sparvm_double_station_main.pro. You can also provide me with your output file, the result from your astrometry analysis software, to create a input routine in IDL for sparvm

6. You should now be ready to run sparvm using your own data. If there is any steps missing, let me know.

E. FAQ

1. *When was this FAQ prepared?*
   This FAQ was prepared for the use of sparvm software at Desert Fireball network, Australia.

2. *What is the full form of SPARVM. What is its purpose ?*
   SPARVM stands for Software for Photometric and Astrometric Reduction of Video Meteors. It was developed during PhD work at Armagh Observatory (2005-2009). The meteor data used during development was Watec Video cameras with ~60 degree field of view, 0.08 degree/pixel of resolution, captured by UFO Capture. The first part deals with Astrometry and Photometry has few restrictions and is more suited for UFO captured videos from medium resolution cameras. The second part deals with double station and orbital element computation, and can be used by other groups. Only the second part of the software was provided to Desert Fireball network group.

3. *What are the technical requirements for SPARVM?*
   SPARVM has been tested using IDL version 7.1 in Ubuntu 11.10. It should work with IDL 6.0 or higher, and any Linux station. It does not work with Mac or Windows.

4. *What other software are needed for SPARVM?*
   SPARVM needs IDL ASTRLIB library and NAIF SPICE (IDL version icy) installed. Astrolib routines are used in numerous places in SPARVM routines, and SPICE routine is only used for computing orbital elements in sparvm_compute_orbit.pro

5. *What is the SPARVM software based on?*
   SPARVM is primarily based on (Ceplecha, 1987, Geometric, dynamic, orbital and photometric data on meteoroids from photographic fireball networks, Bulletin of the Astronomical Institutes of Czechoslovakia, 38, 222-234). However, there are also differences to this method.

6. *What are the major difference between SPARVM and Ceplecha method?*
   i. The orbit is computed using SPICE routines
   ii. The computation of meteor from atmosphere to the Earth's sphere of Influence
   iii. The method to differentiate between radiant and anti-radiant
   iv. SPARVM uses Earth's WGS-84 model to change between geocentric and geographic coordinates
   v. The velocity computed is average velocity, rather than velocity at each point.

7. *Why is average velocity computed ?*
   SPARVM was developed using medium resolution cameras, so the velocity obtained had large uncertainties. Even though velocities has been computed at each point, average velocities are used for computation, as that worked best for Armagh Observatory meteors. If you have higher resolution data, you can use velocity at each point, and also compute deceleration.

8. *Where else is SPARVM used?*
   SPARVM is being currently used in Armagh Observatory and IMCCE/Paris Observatory. Some parts of sparvm has already been modified by the groups there, more relative to their specific image formats, and station requirements. In both places, the complete SPARVM packages is being used. However, for Desert Fireball network, only second part is being used, and thus, most of the software was rewritten and thus can have some bugs/errors, as it has not been tested extensively. The methods used in all three station is the same.

9. *Where are 0 values shown for Orbital elements in Output file ?*
   This can happen for two reason. One reason is that the orbit_code was set to any other value than 'yes', so orbital elements were not computed. Run again the software with orbit_code as 'yes' in

sparvm_configuration. The second reason that the orbit is not computed is if the average of the meteor is not within the 12 – 100 km/s range. It is not possible to compute orbit of meteors with less than 11.2 km/s as it would fall back on to the Earth (SPICE routine gets stuck). Also, meteors (other than hyperbolic meteors) have less than 72.5 km/s. Sometimes, two meteors, even if they occur around the same time, might not be double station meteor, which can give velocities more than 72.5 km/s. A maximum limit of 100 km/s is set in sparvm_compute_orbit.pro

10. *What is the logic of Log File ?*
    All sparvm output that is necessary track the progress of the software is written in Log file. In case, sparvm stops in the middle of run, then the user can see which file has caused the problem. Only a frame work for Log file has been created, and expect the user to add more details depending on their need themselves. It is advisable to create a folder such as sparvm_LOG and save all log files there, and delete them occasionally.

11. Why is there some output in terminal ?
    Only basic output has been set to printout in the terminal. It is expected that the user will change the printout depending on their needs.

12. Can I change the Output file format ?
    Yes you can easily add parameters, or change format of the sparvm output. The output file name is created in sparvm_double_station_main and right after written by using sparvm_write_double_station.pro. If you change the output file, also remember to change sparvm_read_double_station_output.pro accordingly.

13. What other documentation are provided ?
    The two documents (other than this file) provided are the Ceplecha 1998 paper and Prakash Atreya PhD thesis. Since the software precedes these documentations, it is suggested to email patreya@gmail.com any questions. More detail documentation will follow soon.

G. List of sparvm routines

sparvm_cartesian_to_geographic.pro
Converts Cartesian Coordinates (X,Y,Z) of meteors to Geographic (lat,lon,alt)

sparvm_check_inputs.pro
Check input [ra, dec, jd] formats and basic input error checking.

sparvm_check_radiant.pro
Check if the given radiant is visible from the station and correct if it is anti-radiant.

sparvm_compute_orbit.pro
Computes helio centric orbital elements from geocentric (Position, Velocity) state vector

sparvm_configuration.pro
Configuration file for running sparvm double station. Values, paths and filenames are set here.

sparvm_create_logfile.pro
Create log file name.

sparvm_double_station_main.pro
Main routine to run double station.

sparvm_eqn_plane.pro
Computes equation of a plane for a given meteor and station

sparvm_file_time.pro
Get time from the metrec filenames. Used to identify double station meteors

sparvm_geographic_to_cartesian.pro
Converts geographic (lat,lon,alt) of stations to cartesian Coordinates (X,Y,Z)

sparvm_getinfo_station.pro
Get station geographic (lat, lon,alt) information

sparvm_intersect_plane.pro
Intersect two given planes to get meteor radiant

sparvm_lst2lon.pro
Convert from Local Sidereal Time to Longitude

sparvm_meteor_vel.pro
Compute different form of meteor velocity

sparvm_project_plane.pro
Projects meteor position onto a given plane

sparvm_read_double_station_output.pro
Read output files of sparvm software

sparvm_read_metrec.pro
Reads metrec output file

sparvm_test_leonids
Routine to test Leonid 2001 metrec data

sparvm_vel_corr.pro
Corection to meteor velcoity (Earth's rotation and Gravitation) to compute velocity at infinity

sparvm_write_double_station.pro
Write output files of sparvm software