

## Summary of the 22 April, 2020, Videocon

### Attendees were:

Jørgen, Kiran, Jesper, Rafa, Roger, Rachel, Sarbani, Sasha, Sergei, Sylvain, Sushant, Savita

**Rafa** updated the status of low-degree mode fitting for various data sets. His team now has a working Python code and is able to fit GOLF and VIRGO data successfully. However, they are not comfortable with the BiSON fitting since they could not reproduce the results of Rachel and Anne Marie. Rafa suspects that the incorrect background might be introducing some bias that they need to fix. Rafa would discuss with Rachel and Anne Marie to improve his fitting for the BiSON data.

Rafa also reported the time-lag problem in the GOLF data that needs to be fixed from time to time. This was not done since 2006, however they now have updated the time series which is free from the time-lag error.

**Sylvain** reported the progress made by Antonio and him on the Task A.2. Antonio had sent some results to Sylvain but did not include error bars. No results were shared at the meeting.

**Roger** has made significant progress with the surface rotation rate calculations (1996-2011) and shared a power-point presentation. The presentation was later uploaded to

<https://www.dropbox.com/home/Rotation%20Project%20Paper%201/Surface%20Rotation%20-%20Roger>

He found that south-polar region rotated faster than the north-polar region. In this work, a latitude-dependent fixed rotation rate has been used as a reference while in the inversion results (e.g., by Sarbani or Rachel), time-averaged mean values at each latitude are used for reference. Rachel pointed out that the trend at high latitudes might be the reflection of the high-latitude branch seen in torsional oscillation plots, which was stronger in cycle 23 than cycle 24. Jørgen added that these results were unique and that they needed to be compared with the inversion results.

As suggested by Jørgen, Roger also uploaded his results in numerical form after the meeting, and they are available in the above folder. A README file is also included. Roger is planning to extend his work for HMI data.

**Jørgen** discussed Rachel's results on SOLA inversions using artificial data with and without errors,

[https://www.dropbox.com/home/Rotation%20Project%20Paper%201/inversions?preview=rachel\\_combined\\_20200421.pdf](https://www.dropbox.com/home/Rotation%20Project%20Paper%201/inversions?preview=rachel_combined_20200421.pdf)

It should be noted that the results are plotted against the centre of gravity, hence points near the equator are missing. In both cases, the differences between the inversions and true values are smaller at low latitudes while these are significantly higher at high latitudes. In general, the standard deviations are also higher than the errors. It was suggested to understand the effect of trade-off parameters and target width on the inversion that Rachel had already investigated. She did not see any improvements in the results by changing these parameters.

**Rachel** shared additional results on inversions for various trade-off parameters which were later uploaded at

<https://www.dropbox.com/home/Rotation%20Inversions/RachelHowe/20200421>

Each of the files maps1.pdf – maps3.pdf show a variety of results for a given target location ((r/R, lat.) = (0.85, 0 deg.), (0.5, 15 deg.), (0.99, 15 deg.)), for varying trade-off parameters, and maps4.pdf shows the resulting rotation rates, as functions of radius and latitude. It appears that with increasing trade-off parameter, the area decreased where she could find sensible solutions.

Sylvain had some concerns on the selection of trade-off parameters in this work, insisting that there should be some kind of well-defined matrix to judge the quality of the fitting, as a basis for the choice of the optimal parameters. Although the analysis of the artificial data may give some indications for an appropriate choice, he noted that in the absence of systematic errors in Sasha's artificial data where random noise is considered as errors, selection of trade-off parameter is subjective and one cannot rely on the error bars. This initiated a discussion on the role of trade-off parameters and systematic errors in RLS and SOLA inversions with no definite conclusion. It was pointed out, however, that an advantage of the RLS inversions is that systematics may be revealed by the residuals of the data around the best-fitting solution.

Next meeting in mid-May.

### **Action Items:**

Since we have started identifying various tasks by the item numbers, it is decided to keep the same numbering as we move forward. Now onwards, the action item list will have all old and new tasks.

**Note: Actions have already been taken on the highlighted items. No further work is required.**

Carryover action item list

**A.1: Use fixed and reasonable plot limits in plots of inversion-result differences (JC-D)**

A.2: Investigate causes of excessive error estimates in inversions of individual splittings (SGK, AE-D)

**A.3: Inversion results for artificial data on standard form (RH)**

**A.4: More extensive results on standard form (SV)**

**A.5: Consider determination of statistical errors and centres of gravity of averaging kernels (SB, HMA)**

A.6: Find optimal inversion parameters and produce results on standard form (all inverters)

A.7: Include measures of inversion resolution in radius and latitude in numerical output (all inverters)

**February 13, 2020**

A.8: Consider ways of displaying resolution results (JC-D)

A.9: Analysis of averaging kernels, determination of radial and angular extent (JCD, RH)

A.10: Include measures of inversion resolution in radius and latitude in numerical output (all inverters)

A.11: Understand differences found by Sarbani and Antia in a coefficients, relative to Sasha's (SB, HMA, AK)

***March 17, 2020***

A.12: Input for the paper based on the work discussed at the meeting (SB, HMA) (included in meeting summary)

A.13: Format for averaging kernels in (x, y) grid (JCD)

A.14: Notes on today's (March 17, 2020) discussion (SVV) (included in meeting summary)

***April 22, 2020***

A.15: Compare and consolidate treatment of background in analyses of GOLF and BiSON data (RH, RG)

A.16: Analyse SOLA inversion results with different trade-off parameters, attempting higher resolution at the expense of higher errors (RH, JCD)

A.17: Surface rotation results to be provided in numerical form (RKU)

**Of course A.2 still needs action from Antonio, and for A.9 JCD hopes to get a representative selection of averaging kernels for the SOLA inversions from Rachel.**