RVS Telemetry

Telemetric flows for the RVS computed by using star counts from GSC-2.2 catalogue

RVS-YV-001

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(Note for the livelink)
Telemetry Budget for GAIA- RVS
RVS parameters (Vth Paris Workshop)

- **Résolution** = 11500 (sampling = 0.375 A/pixel)
- **Size of single spectrum**
  - along scan = 694 pixels
  - across scan = 1 or 2 pixels
- **Detector**: 3 CCD of 2020 x 3930 pixels
- **Pixel size**: 0.982" x 1.473"
- **RVS-FOV size**: 2° x 1.6°
- **RVS-FOV transit time** = 120 s (one GAIA rotation in 6 h)
- **Whole GAIA mission** = 1800 days = 7200 rotations
  = 1 296 000 successive juxtaposed RVS-FOVs
Positions of the three instruments in the GAIA Reference System (GRS)

Sequence

Observation

\( t = 0 \)       Spectro

+ 38 mn       AF1

+ 106 mn       AF2

+ 216 mn       Spectro

etc...
RVS-FOV "pavement" or sampling
Star distribution throughout the sky: The GSC-II catalog

- 1" resolution scans of the **photographic Sky Survey plates** (Palomar and UK Schmidt telescopes)

- **Now**: version 2.2: 445 851 237 objects
- **Final (2003)** version: 998 402 801 objects

- Magnitude limits (catalog complete to magnitude limit):
  - 18.5 in photographic F bandpass ($\lambda_0 \sim 0.71$ μm)
  - 19.5 in photographic J bandpass ($\lambda_0 \sim 0.44$ μm)

- V ($\lambda_0 \sim 0.55$ μm) magnitudes available for some stars
Star counts from the GSC-II catalog

- Five class of objects (only two (in red) in present version 2.2)
  - Star
  - Galaxy
  - Blend
  - Non-star
  - Unclassified
  - Defect

- Counting of objects by magnitude interval in the three bands (F, J and V) of GSC-II catalog (up to magnitude limit of each band)

- Sky coverage: done for directions separated by 1° in the ranges
  - $-90^\circ \leq b \leq +90^\circ$, $0^\circ \leq l \leq 360^\circ$ (--> overlap of boxes)

- For each $(l, b)$ we give the number of star per square degree and magnitude interval: $\leq 0$, and every half magnitude up to magnitude limit (18.5 in F and 19.5 in J). We count:
  - Stars
  - Non stars
  - Total: stars + non stars
<table>
<thead>
<tr>
<th>Magnitude limit</th>
<th>Galactic latitude</th>
<th>Galactic latitude</th>
<th>Galactic latitude</th>
<th>Galactic latitude</th>
<th>Galactic latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 ≤</td>
<td>b</td>
<td>≤ 5</td>
<td>5 ≤</td>
<td>b</td>
</tr>
<tr>
<td><strong>14</strong></td>
<td>700</td>
<td>1 537</td>
<td>600</td>
<td>1 320</td>
<td>360</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td>1 600</td>
<td>3 744</td>
<td>1 400</td>
<td>3 173</td>
<td>800</td>
</tr>
<tr>
<td><strong>16</strong></td>
<td>3 800</td>
<td>8 356</td>
<td>3 200</td>
<td>6 984</td>
<td>1 800</td>
</tr>
<tr>
<td><strong>17</strong></td>
<td>9 100</td>
<td>16 747</td>
<td>7 400</td>
<td>13 804</td>
<td>3 900</td>
</tr>
<tr>
<td><strong>17.5</strong></td>
<td>13 600</td>
<td>**</td>
<td>11 000</td>
<td>**</td>
<td>5 500</td>
</tr>
<tr>
<td><strong>18</strong></td>
<td>20 300</td>
<td>29 229</td>
<td>16 300</td>
<td>23 905</td>
<td>7 800</td>
</tr>
</tbody>
</table>
Number of stars observed per day by RVS during the whole GAIA mission

Starcount: GAIA-CTSR model and GSC 2.2 - F and J bands, Magnitude limit = 18

Times in days from J2000.0
Number of objects in the GSC-2.2 F-band observed per day by RVS during the whole GAIA mission.

Magnitude limit = 18

Times in days from J2000.0
Two magnitude limits $F = 17$ and $F = 18$

Sum of 3 CCDs before sending data to the ground

1) Spectrum width = 2 CCD rows $\Rightarrow$ 1388 pix/spectrum for all objects up to the limiting magnitude

2) Spectrum width = 1 row 50% observing time and 2 rows the other 50%

A full spectrum sent for $F \leq 16$

Only CaII lines, i.e. half spectrum, sent for $F > 16$
CCD filling in crowded FOVs

Lower limit of star density that fills the CCD:

\[ N_{\text{crit}} = \frac{S_{\text{ccd(pix)}}}{(S_{\text{ccd(deg)}} \times n(\text{pix/object}))} \]

Assumes:
1) uniform distribution
2) no overlap of spectra

\[ S_{\text{ccd(pix)}} = 2020 \times 3930 = 7,938,600 \text{ pix} \]

\[ S_{\text{ccd(deg)}} = 0.551 \times 1.608 = 0.886 \text{ square degree} \]
<table>
<thead>
<tr>
<th>Spectrum width</th>
<th>Magnitude limit</th>
<th>Mean number of pixels per spectrum</th>
<th>Number of stars per square degree that fills a CCD</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 CCD rows</td>
<td>17, 18</td>
<td>1 388</td>
<td>6 450</td>
</tr>
<tr>
<td>2 rows (50%), 1 row (50%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half spectrum for F &gt; 16</td>
<td>17</td>
<td>781</td>
<td>11 470</td>
</tr>
<tr>
<td>2 rows (50%), 1 row (50%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Half spectrum for F &gt; 16</td>
<td>18</td>
<td>651</td>
<td>13 740</td>
</tr>
</tbody>
</table>
RVS–FOV–cells filling from J = 0 to J = 1800
Galactic coordinates, Magnitude limit = 18, R = 11500, Row/spectrum = 2
Fraction of FoV–cells full = 0.33
RVS–FOV–cells filling from $J = 0$ to $J = 1800$

Galactic coordinates, Magnitude limit = 18, $R = 11500$, Row/spectrum =

Fraction of FoV–cells full = 0.19
RVS–FOV–cells filling from $J = 0$ to $J = 1800$

Galactic coordinates, Magnitude limit = 17, $R = 11500$, Row/spectrum =

Fraction of FoV–cells full = 0.21
RVS–FOV–cells filling from $J = 0$ to $J = 1800$

Galactic coordinates, Magnitude limit = 17, $R = 11500$, Row/spectrum =

Fraction of FoV–cells full = 0.09
Telemetric flows per day for RVS from GSC-2.2 counts in F-band during the whole GAIA mission

Magnitude limit = 18. Four RVS "configurations" (spectrum width 1 or 2 rows, 1 or 3 CCD)
Telemetric flows per day for RVS from GSC-2.2 counts in F-band during the whole GAIA mission

Magnitude = 18 : red curves - Magnitude = 17 : blue curves
GAIA - RVS: Fraction of data saved versus compression factor

gscII-Fband (star + non star)

Telemetry budget allocated to RVS = 0.25 Mbits/s

<table>
<thead>
<tr>
<th>Compression factor</th>
<th>F = 17</th>
<th>F = 18</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n(pix/obj)</td>
<td>n(pix/obj)</td>
</tr>
<tr>
<td></td>
<td>1388</td>
<td>781</td>
</tr>
<tr>
<td>1</td>
<td>14,5%</td>
<td>20,4%</td>
</tr>
<tr>
<td>2</td>
<td>28,9%</td>
<td>40,8%</td>
</tr>
<tr>
<td>3</td>
<td>43,4%</td>
<td>61,2%</td>
</tr>
<tr>
<td>4</td>
<td>57,8%</td>
<td>77,2%</td>
</tr>
<tr>
<td>5</td>
<td>72,2%</td>
<td>84,7%</td>
</tr>
<tr>
<td>6</td>
<td>80,8%</td>
<td>89,6%</td>
</tr>
</tbody>
</table>
Conclusion : Future work

(1) Improve telemetry budget within each FoV-cell

- Statistical study of the degree of crowding versus stellar density

- Spectrum overlap between close objects
  - # occurs well below the densities that fills the CCD, in fact at any density
  - # increases the effective stellar density that fills the CCD
  - # reduces the telemetric flow per FoV-cell

===> mean number of occupied pixels within each FoV as a function of stellar densities (galactic coordinates)
Conclusion : Future work

(2) Check the impact of data pre-processing on telemetry budget

- Check feasibility of proposed pre-processing operations
- Refine distribution of spectrum position and profile with respect to CCD rows ==> extraction of 1 or 2 rows
- Possible various pre-processing according to magnitude ==> telemetry budget function of magnitude (distribution get from catalogues)

(3) Stars selection strategy

- Impact on selection algorithms (fifo, adopt different magnitude limit of objects sent to the ground according to density...) on telemetry budget
Conclusion: Future work

(4) Translate GSC-II F photographic magnitudes into RVS-band magnitude \(\rightarrow\) star counts and telemetry budget in this band

(5) Telemetry budget using other star catalogues: e.g., point sources DENIS catalogue (Advantage: I magnitude corresponds to RVS bandpass), USNO-B1

(6) Star counts with higher spatial resolution on the sky: 6'x6' (instead of 1°x1°) for \(|b| \leq 10°\)

Telemetry budget for other GAIA instruments (Astro 1 and 2, MPB) (Star counts + extrapolation down to \(G = 21\)