Interplanetary Scintillation Observations of the Large-Scale Solar Wind Subsidence Event of May 1999

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Short title: LARGE SCALE SUBSIDENCE OF THE SOLAR WIND IN MAY 1999

Abstract.

We report extensive Interplanetary scintillation (IPS) observations of the solar wind during the period centered around May 11, 1999 when the earth was engulfed by a region of solar wind with unusually low densities (< 1 cm^{-3}) and velocities (< 350 km s^{-1}).

IPS observations with the Ooty Radio Telescope (ORT), operating at 327 MHz, can probe the inner heliosphere along a large number of closely spaced lines of sight over the heliocentric distance range of 0.2 to 1.0 AU, rather rapidly at the rate of about 200 sources in the course of ten hours. Using IPS observations, the southern half of the inner heliosphere was monitored everyday between 3 and 16 May 1999. The data show that the solar wind densities were globally subdued, having started subsiding from May 3, 1999 itself at different parts of the heliosphere. This was accompanied by a noticeable decrease in the velocity of the general solar wind also. The IPS data also reveal a small subset of closly spaced sources lying to the west of the sun that show a steep drop in g-values to unmeasurably low amounts on and around the 11th May. The actual morphology of the subsidence event, as inferred by IPS observations, is shown to be that of a "void-within-a-void". To the best of our knowledge this is the first time that sustained levels of low densities and velocities have been recorded for such a long period over a large part of the inner heliosphere.

1. Introduction

IPS observations of compact extragalactic radio sources provides one with an effective and cheap ground based method for studying the large scale properties of the solar wind plasma. Some of the main parameters measurable by IPS are the root mean square deviation in electron density, the scale size distribution of the density irregularities and the velocity of the solar wind. These parameters are derived from the power spectrum of the observed intensity fluctuations of compact extragalactic radio sources. The ORT, with an effective collecting area of about 8500 m^2 and a declination (δ) coverage of -60° $\leq \delta \leq$ +60°, can observe about 200 scintillating sources in the course of ten hours yielding high signal to noise ratio (S/N) IPS power spectra with data stretches as short as two minutes. The spectra can be used to estimate the electron density fluctuations (ΔN_{rms}) in the solar wind and to derive the velocity of the solar wind across the line of sight (LOS) to the source [*Balasubramanian et al.* 1995; *Janardhan et al.* 1996]. At 327 MHz, the coverage in solar elongation (ϵ), which is the angle between the LOS to the source and the sun-earth line, is $10° \leq \epsilon \leq 60°$. This corresponds to $40R_\odot \leq r \leq 190\ R_\odot$ where, r is the distance between the sun and the LOS to the source and $R_\odot$ is the solar radius. Thus, regular IPS observations of a large number of compact, spatially well distributed radio sources can not only be used to get a large scale picture of the density fluctuations and velocities prevailing in the solar wind but can also be used to track traveling IPD on a day-to-day basis [*Janardhan et al.* 1996; *Balasubramanian et al.* 1996].

Whenever a source exhibits IPS one can look for deviations from "*normally expected IPS behavior*" which can be quantified in terms of the value of a a normalized scintillation index (m) defined as, g = $m(\epsilon)_{obs}$ /$m(\epsilon)_{exp}$. Here m is the ratio of the root mean-square deviation of the signal intensity to the mean signal intensity, while $m(\epsilon)_{obs}$ is the observed m at a given ϵ and $m(\epsilon)_{exp}$ is the expected average m of the source at the same ϵ [*Hewish and Bravo* 1986]. Using over two years of data around solar maximum in 1978–1979 [*Hewish, Tappin & Gapper* 1985] showed that there was no evidence for enhanced or decreased scintillation that was not associated with corresponding variations in density. IPS can therefore be used with confidence to monitor plasma density along the LOS to a source even though it measures only the fluctuation in density and not the density itself.

The reliable determination of solar wind velocity from single station IPS data, requires that the S/N of the power spectra are at least 10 db above the background noise level [*Tyler et al.* 1981; *Scott Coles & Bourgois* 1983; *Manoharan and Ananthakrishnan* 1990]. This implies that while g can be determined for a large number of scintillating sources the velocity can be derived only for lesser number of sources which scintillate well.

2. The May 1999 Observations

From May 3, 1999 to May 16, 1999 a large portion of the southern part of the inner heliosphere was monitored, by IPS observations with the ORT, on a daily basis. The data obtained were unique in the sense that scintillation levels for all the sources were much below normal. The data, reduced to a g-value for each observation, are shown in Figure 1a, Figure 1b and Figure 1c which we refer to as 'g-plots'. Each panel of Figs. 1a, 1a and 1b shows a polar plot of g values for one day of observations. The finely dotted circles are circles of equal ϵ with the sun at the center. The noticiable feature of the plots is that the g values are almost everywhere much less than unity, indicating that the entire IPM was experiencing lower than normal densities. This is unusual as one would expect the general scatter in the g-plots to be around a mean g of unity under normal conditions, as is implied by the definition of g. The data show that turbulence in the IP medium remained low for a prolonged duration of several days over a large part of the inner heliosphere.

Figure 1a

Figure 1b

Figure 1c

Although other instances of low densities in the IP medium have been reported earlier [*Gosling et al.* 1982; *Schwenn* 1982; *Phillips et al.* 1989], with the most recent being in the ORT data of August 1998 during the Whole Sun Month II campaign (to be published later), these were of much shorter duration. The uniqueness of the data for 3 to 16 May 1999 becomes clearer if we bear in mind that the usual trend of IPS data is such that the g values are scattered around a mean value of unity. Such "*typical*" behavior of g-plots has been noted from several years of IPS observations on a large number of scintillating sources. Figure 2 compares the data of May 1999 with that of August 1998 and May 1995, during the approach to solar maximum and during the solar minimum respectively. During both these periods a stretch of one month of data has been shown when the solar wind was monitored with the ORT in a manner similar to that of the May 1999 period under discussion. Results from the observations during

Figure 2

August 1998, during what is known as the Whole-Sun-Month II campaign may be found in [*Moran et al.* 2000]. The three panels in Fig. 2 show the solar wind velocity plotted versus g for the period May 1999 (upper panel), May 1995 (middle panel) and August 1998 (lower panel). It is clear from Fig. 2 that the distribution of data in May 1999 resembels the period of solar minimum rather than that of solar maximum. The data of August 1998, during the approach to maximum, shows the normal expected scatter around a g-value of unity and the while the May 1999 data shows a g value distribution with a large number of g values lying well below unity, in a manner similar to what is expected during solar minimum.

3. The Distribution of Low g Values :

Figure 3 shows the distribution of g values plotted as histograms on each day of observations. It is evident from Fig. 3 that while the densities inferred on all days was largely subdued i.e. g <1.0, for most of the observations, the g-values recorded on 11 May 1999 were even more so as compared to the other days. Of a total of 120 observations on 11 May 1999 around $\sim$95% of the sources showed densities ≤ 0.6 with $\sim$80% of the sources having g-values ≤ 0.3. On all other days, the distribution showed approximately 60% of the sources with g-values ≤ 0.3 and $\sim$80% with g ≤ 0.6. Figure 3

This distribution of g values may be contrasted with in-situ spacecraft measurements of density. During the interval from about 00 UT May 10 to $\sim$18 UT May 11, the density of protons in the solar wind, as recorded by the WIND spacecraft, started decreasing exponentially, dropped to below 1 cm^{-3} and went down to values as low as

$\sim$0.2 cm^{-3} [*Farrugia et al.* 2000]. Similar data from ACE SWEPAM showed that the proton density started decreasing from a few particles cm^{-3} at about 06 UT on May 10. It reached values less than 1 cm^{-3} by about 18 UT on May 10, and continued to decrease further. By about 00 UT on May 12 it was immeasurably low. The densities started increasing on 12 May from about 02 UT and built up to the level of a few tens of protons cm^{-3} by about 16 UT on the same day. Figure 4 reproduces the hourly averaged proton densities recorded by ACE SWEPAM from May 1–17 1999 (http://www.srl.caltech.edu/ACE/level2/swepam_12 desc.html). The important point to bear in mind is that the in-situ measurements indicate normal density levels before and after the steep dip on 11 may 1999. Our IPS measurements on the other hand, cover extensive regions of the inner heliosphere and clearly indicate that the entire inner heliosphere has less than normal densities well before 11 May and the densities had not returned to normal values even by 16 May 1999. In addition to this, of the approximately 285 sources observed by IPS during the period 3–16 May 1999 a small subset of sources showed a steep fall in g values on and around 11 May 1999, in a manner similar to that observed by spacecraft. Figure 4

Figures 5a and 5b plots g as a function of date for this small subset of sources. Also indicated in each plot are the source names, the helio latitudes and longitudes and the distance in AU from the sun of the point (P-point) along the LOS to the source that is closest to the sun. Figure 6 is a polar plot of the sources in Figs. 5a and 5b. All of the sources are located west of the sun-earth line and occupy a region between 0.5 AU and 0.8 AU. From the values of latitude, longitude and distance for these sources in Fig. Figures 5a 5b Figure 6

5a and 5b we may note that the LOS to these sources probe a localized region of the IP medium. It is thus clear that the scenario in the IP medium in this period was that of a "void-within-a-void", with a small region of the IP medium showing a near absence of particles (indicated by the sources for which g's drop to zero) while the rest of the IP medium had lower than normal densities (indicated by the majority of observed sources for which g's are well below normal).

4. Solar Polar Field Reversal and Coronal Magnetic Field

4.1. Field Reversal

A probable explanation for the above observations could lie in the fact that the solar polar field was undergoing a reversal during the period. The periodic 22 year solar magnetic cycle starts with the rapid poleward extension of the heliospheric current sheet (HCS). The existing magnetic fields at the poles of the sun are thus carried to the opposite poles in approximately 6 to 8 solar rotations, thereby causing a polar field reversal. The rapid poleward extension, at the start of the new magnetic cycle, began in CR1947 [*Usmanov et al.* 2000] and the polar field had reversed by CR1954 [*Asaoka et al.* 2002]. It is entirely possible that such changes would lead to a large non-radial component in the interplanetary magnetic field and hence less-than-normal or subdued solar wind densities over extended spatial extents and periods of time in the interplanetary medium. Since IPS is very sensitive to changes in densities, it can easily record this large scale density subsidence in the solar wind. In fact, [*Usmanov et al.*

2000] have concluded that the deformation of the HCS that takes place during such field reversals, at the beginning of any solar activity cycle, is likely to be associated with density anomalies. Possibly, it was not coincidental that a rapid increase in sunspot numbers was also observed during 3–16 May 1999 as shown in Table 1 which lists respectively the sunspot numbers and the corresponding day for the period 3–16 May 1999.

Table 1

4.2. Coronal Magnetic Field

Coronal magnetic structure essentially reflects force balance between the magnetic field and the solar wind streams in the corona. The origin of solar wind velocity and density structure can therefore be inferred by looking at the coronal magnetic field structures. The coronal magnetic field cannot be measured directly, but can be computed, [*Hakamada & Kojima* 1999], using measured values of the photospheric magnetic field coupled with a potential field extrapolation. Figure 7 shows the computed three dimensional structure of the coronal magnetic fields for Carrington Rotation 1949. The solid line marks the location of the HCS. The magnetic field lines, shaded differently to distinguish the two polarities, are shown projected on to a source surface at 2.5 $R_\odot$ beyond which the potential field lines are supposed to be radial. In order not to clutter the figure with too many lines, only fields between 5G and 250 G on the photosphere are plotted in Fig. 7. The plot is viewed from 240° in Carrington longitude and 30° in heliographic latitude. The fields were computed by using a potential field analysis wherein the magnetic potential is determined by spherical harmonic expansion

Figure 7

of Laplace's equation. The coefficients of the harmonic series are computed by a method devised by [*Hakamada & Kojima* 1999].

In Fig. 7 the mid latitudes in both hemispheres are almost entirely dominated by closed loop structures. The only exception is the large open field structure on the west limb originating at the boundary of the HCS. This open field region fans out into interplanetary space from a small region of the photosphere, otherwise dominated by closed loops. Thus any coronal activity located approximately at disk center two to three days before 11 May 1999 and rotating on to the west limb can either sweep out matter into the IPM along these open field lines, towards the direction of the earth, or further deplete the IPM by sweeping matter ahead of it in a shell which is followed behind by a large low density region. A close look at Figs. 5a and 5b shows that a number of IPS sources showed a rise in the g-values, prior to the steep fall. This is indicative of a high density front or shell crossing the LOS to the sources. If the IP medium is already experiencing a large scale subsidence in the densities, then an appropriately direced CME could cause a further depletion behind its leading edge thereby giving rise to a "void-in-a-void" that we postulate.

5. Stray High Velocities

Owing to the unusually low levels of scintillation which prevailed during the period, many sources which would scintillate during normal solar wind conditions showed only weak or no scintillations. This caused the number of velocity points obtained to be far less than normally expected. When compared with our observations at other times, the number of sources that showed IPS during the May 1999 period was less than half.

From our velocity data for the May 1999 period it was seen that solar wind velocities tended to be lower than usual. On 4th and 5th May 1999 the daily mean value (i.e. the average of measurements on several sources observed on a day) was about 360 km s^{-1}. On 6th May 1999 there was a perceptible drop in the mean velocity. Low velocities continued to prevail till 11 May 1999. The daily mean on 10 May 1999 was as low as 285 km s^{-1}. On 12 May 1999 velocities started increasing after 0900 UT; they went up from $\sim$270 km s^{-1} to $\sim$385 km s^{-1}. However, the daily mean of solar wind velocities remained in the range 310 to 340 km s^{-1} during 13 - 16 May 1999.

A notable feature in the velocity data was that at a few stray LOS high solar velocities ($\sim$1000 km s^{-1}) were found to occur. These high speed components were due to "two stream" IPS power spectra which had two components - one, a normal solar wind component and the other, a high speed component. Fitting the two components of the spectra yields two different values of solar wind velocty, a low value and the other a high value [*Moran et al.* 2000]. It was noted further that whenever such a high velocity stream occurred at any solar elongation it was not accompanied by high velocities at adjacent elongations.

Table 2 summarizes the occurrence of the few stray high speed solar wind streams crossing the LOS to the scintillating sources, as detected by our IPS observations on 8, 9, 10, 12 and 13 May 1999. The columns in Table 2 list respectively, the date of observation in May 1999, the time of observation in UT, the ϵ of the source, the S/N of the observed IPS spectra, and the derived two-stream (low and high) solar wind

Table 2

velocities. Such two-stream IPS spectra are abnormal and can be easily identified and model-fitted to yield the velocities of both the high velocity stream crossing the LOS and the background low speed solar wind [*Moran et al.* 2000].

The possibility of these high velocity points arising due to the passage of traveling IPD was ruled out by examining other reports on the timings of occurrences of transient solar surface phenomena such as flares and CMEs. It may be noted further that the typical signatures of traveling IPDs crossing the LOS to IPS sources are invariably such that they show up as enhanced velocities or enhanced g values for several closely spaced LOS at adjacent ϵ [*Janardhan et al.* 1996].

It is difficult to understand the occurrence of such high velocities along isolated, stray lines of sight. On each of these days i.e. when such high velocities were observed at stray ϵ, there are measurements of velocities at several closely spaced LOS at adjacent ϵ which showed "*normal*" velocities only. These stray high velocities, inferred from the IPS power spectra, imply that the turbulence along the LOS to the particular source was dominated by isolated, collimated, high velocity streams crossing the LOS at or near its point of closest approach to the sun. This is due to the fact that the IPS method of velocity measurement gives high weightage to the solar wind that crosses the LOS at its closest point of approach to the sun. A probable explanation for such stray, high speed streams is that they are the highly collimated " *strahl*" electrons proposed by [*Fairfield & Scudder* 1985].

It is interesting to note that high speed streams due to strahl electrons were being detected in our IPS data from 8 May itself (Table 2) whereas polar showers of strahl electrons were detected on the earth's north pole by WIND only from 9 May 1999, with the intensities peaking on 11 May 1999 [*Farrugia et al.* 2000]. The occurrence of strahl streams seem to have tapered off after 13 May 1999 as seen from IPS data summarized in Table 2. The main point is that strahl streams have occurred across several LOSs over a large spatial extent of the inner heliosphere as monitored by IPS. This is in contrast with *in-situ* spacecraft data which can monitor only narrow regions of the earth's proximal space.

6. Discussion

As pointed out earlier the IPS technique is useful for monitoring solar wind densities and velocities over large regions of the inner heliosphere rapidly. Depending upon the ϵ of the scintillating source the closest point of approach to the sun of the LOS to the source can be much closer to the sun than the location of the usual spacecrafts which monitor the solar wind. The implication is that the IPS technique senses the solar wind properties a few tens of hours earlier than the epoch at which the changes in the solar wind may be experienced at the earth.

From the daily plots of g derived from our IPS data we see that significant decrease in the g values have started from May 7 itself. This is over and above fact that g values were low from May 3 itself. The trend of low g started reversing from May 12 but even by May 16 the g values did not get restored to normalcy.

It is interesting that IPS monitoring showed that apart from the general decrease in in densities over a large region of the IP medium there was further depletion in solar wind densities over a spatially localized region, around May 11 on the side to the west of the sun - earth line. In order to check whether such a localized void in the IP medium could have been caused by any traveling interplanetary disturbance (IPD) arising due to solar surface events such as CME we examined data on the list of CMEs observed by the coronagraphs in the SOHO spacecraft. Several small CME events were found to be recorded by the SOHO instruments, but there were no spectacularly powerful event. By using the times and spatial locations of occurrences of such weak CMEs we tried to unambiguously associate the localized void seen in IPS with any one of these CMEs. These exercises were unsuccessful.

During the period under discussion, the solar surface had a large number of active regions and a rapidly deforming heliospheric current sheet(HCS). The presence of a large number of active regions with interconnected closed loop magnetic field lines suggests that the solar magnetic field lines were by and large closed over large portions of the solar surface, thereby inhibiting fast solar wind outflows. The lower-than-normal solar wind speeds observed by IPS over a large part of the IP medium are in consonance with such a magnetic field configuration.

As was noted by [*Lazarus* 2000] other instances of low-density solar wind have now been found, but this period of more than 27 hours was the longest having density below 1 particle cm^{-3}. It is not known,however, as to why such periods of low density occur. [*Richardson et al.* 2000] have examined near-earth measurements of solar wind density data from Solar Cycle 20 onwards and have concluded that most such low density events are associated with transient solar wind structures and ejecta like CMEs. We have examined the white light observations of the LASCO coronagraphs during May 1999 and have found no significant events with which to associate this low density period. In a recent paper [*Vats et al.* 2001] have discussed the same event of May 1999 and based on very scanty data have concluded that 'this was mostly a normal plasma flow in most of the medium'. This is clearly not the case, as seen from our extensive data set. The inference from our data is that there could have been fortuitous magnetic field configurations on the Sun resulting in low velocity, low density heliospheric environment and as a consequence a long stretch of low density turbulence. Corroboration for this view comes from [*Schwenn* 1982] who reported three 'strange and rare excursions from the average solar wind'. Two occured in November 1979 while the third occured in June 1980. The densities in the solar wind during the event of June 1980, dropped over a period of a day to well below 1 cm^{-3}. It may be noted that 1980 was the year of the solar maximum with the polar field reversal taking place.

7. Conclusions

While near-earth spacecraft observed the solar wind densities and velocities drop to unusually low values between 10-12 May 1999, IPS observations of a large part of the southern heliosphere have shown that the decrease in electron density fluctuations began right from 3 May 1999. Such subsidence was accompanied by a perceptible decrease in the speed of the solar wind from 7 May 1999 itself. Since the IPS observations were available only in the period 3-16 May, it is difficult to say when exactly the IP densities and velocities began to decrease and when it recovered to normal solar wind values.

However, our IPS data indicate that the restoration of normal conditions began by the latter half of 12 May though it was not completed till 16 May 1999.

Apart from the general decrease in densities over a large portion of the IP medium it was seen that there was a loclized region within the large void where there was further depletion of electron densities - i.e. a void within a void was observed.

The subsidence in electron density fluctuations was also accompanied by the detection of high speed streams along several trajectories in the IP medium. These were most probably due to the highly collimated, and closely field-aligned beams of strahl electrons due to polar field lines connecting back to the sun [*Fairfield & Scudder* 1985]. The occurrences of strahl electrons were found during 8–13 May 1999.

As stated earlier, this period was the longest observed of having solar wind densities below 1 particle cm^{-3}. However, it is not known now as to why such periods of low density occur and what its solar origin is. It is possible that changes taking place in the coronal magnetic field structure during a polar magnetic field reversal can be accompanied by the emergence of less energetic solar wind flows.

Since the near-earth environment frequently encounters phenomena whose solar origins are unclear IPS monitoring of the solar wind, which provides an overall view of the inner heliosphere, using an international network of IPS stations is therefore an important tool in studying the solar wind and the sun-earth connection.

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Figure 1a. polar plots of g values for each day of observations. The finely dotted circles are circles of equal elongation with the sun at the center. The various ranges of g values are shown by different symbols. It may be noted that g=1 implies that the solar wind densities are normal, while g < 1 and g > 1 imply depleted and enhanced densities respectively.

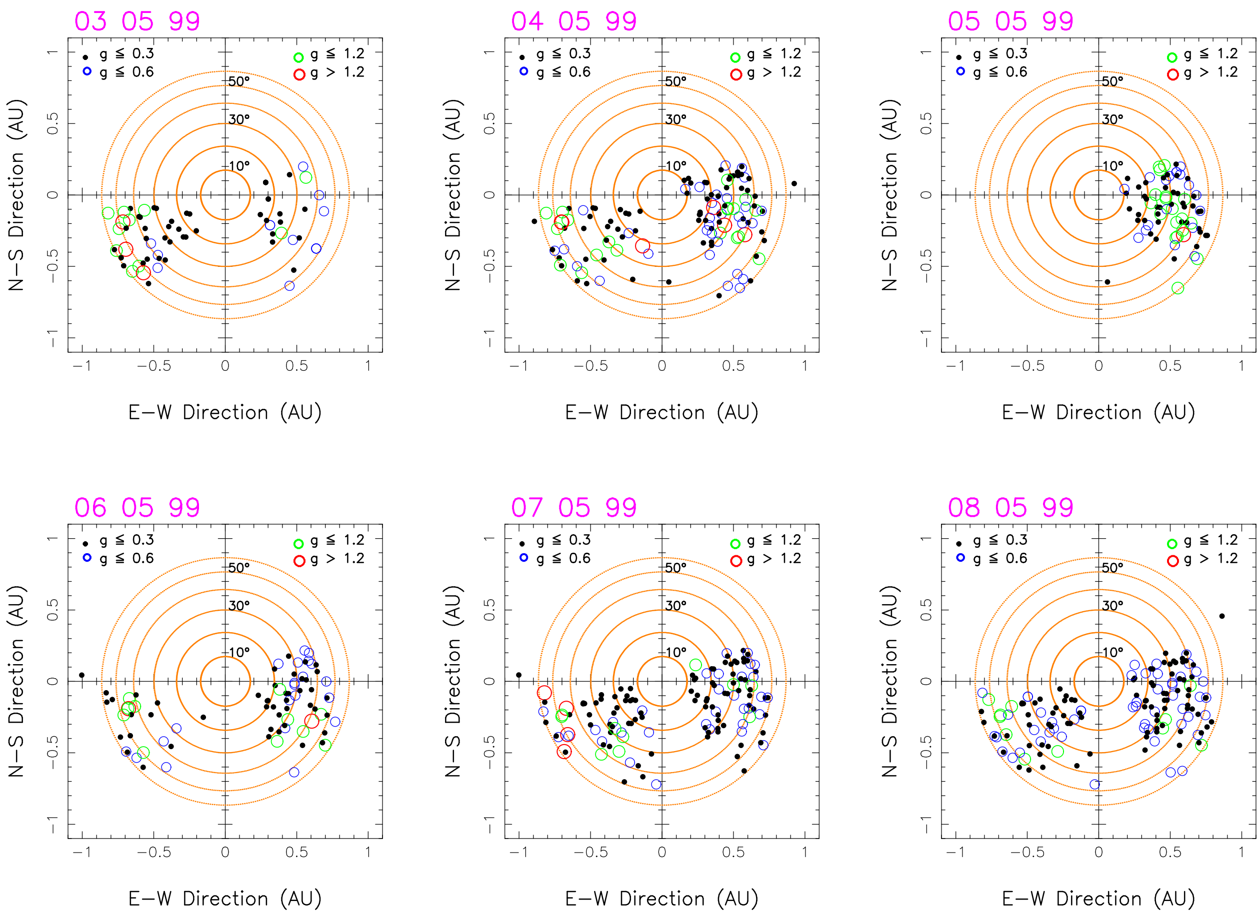

Figure 1b. polar plots of g values for each day of observations. The finely dotted circles are circles of equal elongation with the sun at the center. The various ranges of g values are shown by different symbols. It may be noted that g=1 implies that the solar wind densities are normal, while g < 1 and g > 1 imply depleted and enhanced densities respectively.

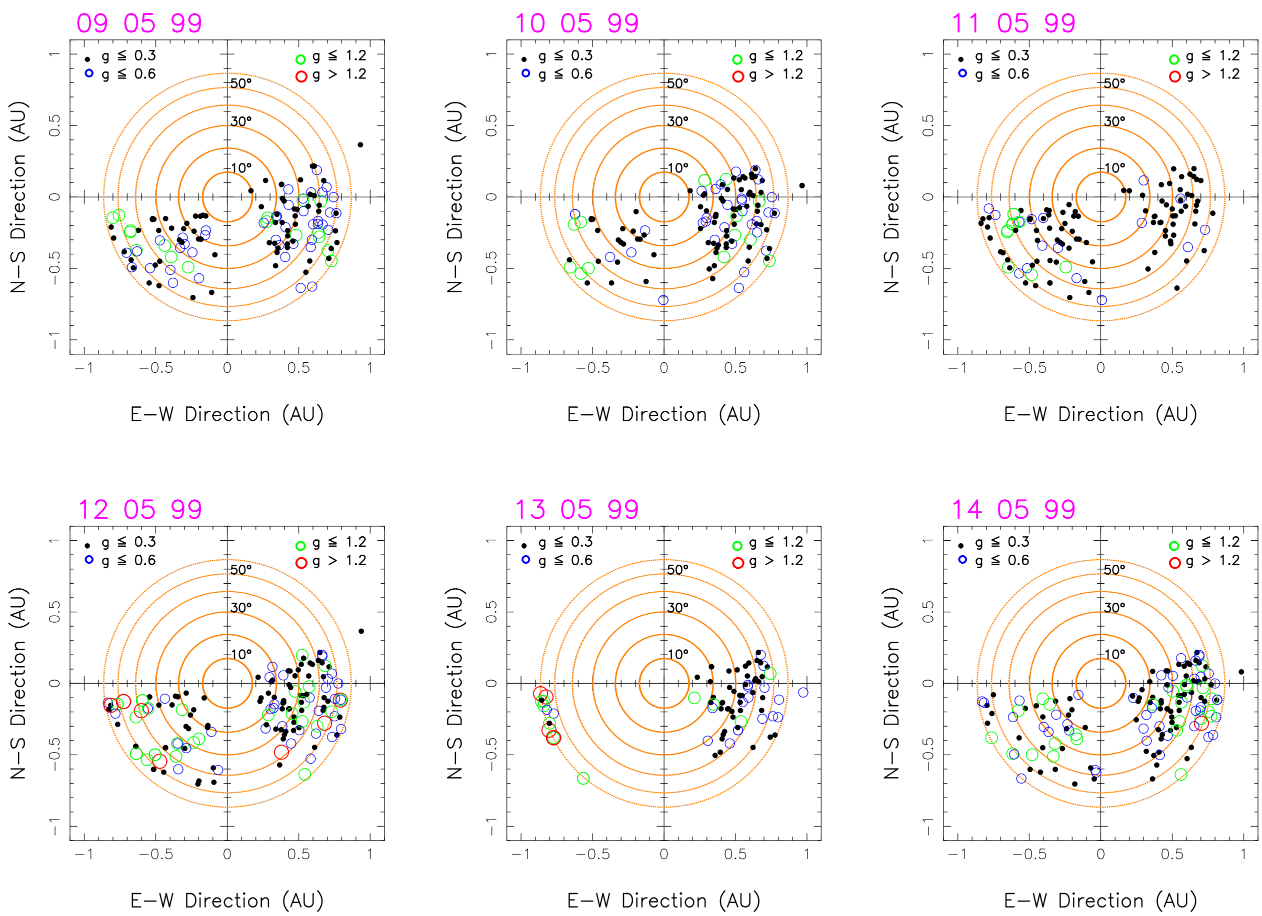

Figure 1c. polar plots of g values for each day of observations. The finely dotted circles are circles of equal elongation with the sun at the center. The various ranges of g values are shown by different symbols. It may be noted that g=1 implies that the solar wind densities are normal, while g < 1 and g > 1 imply depleted and enhanced densities respectively.

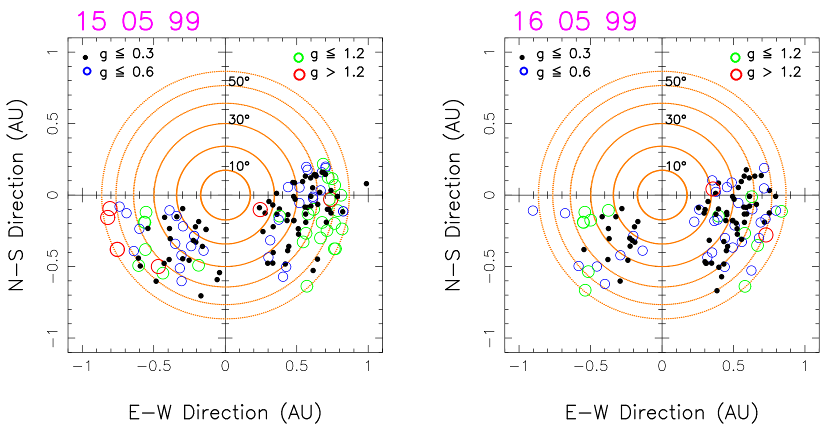

Figure 2. Velocity values versus g during the subsidence event in May 1999 (top panel), around the solar minimum in May 1995 (middle panel), and August 1998 (bottom panel). The data of May 1995 and August 1998 shows normal expected distribution of g values during minimum and maximum years. However, the data of May 1999 is clearly abnormal, resembling the distribution during solar minimum conditions with extremely few g values greater than unity.

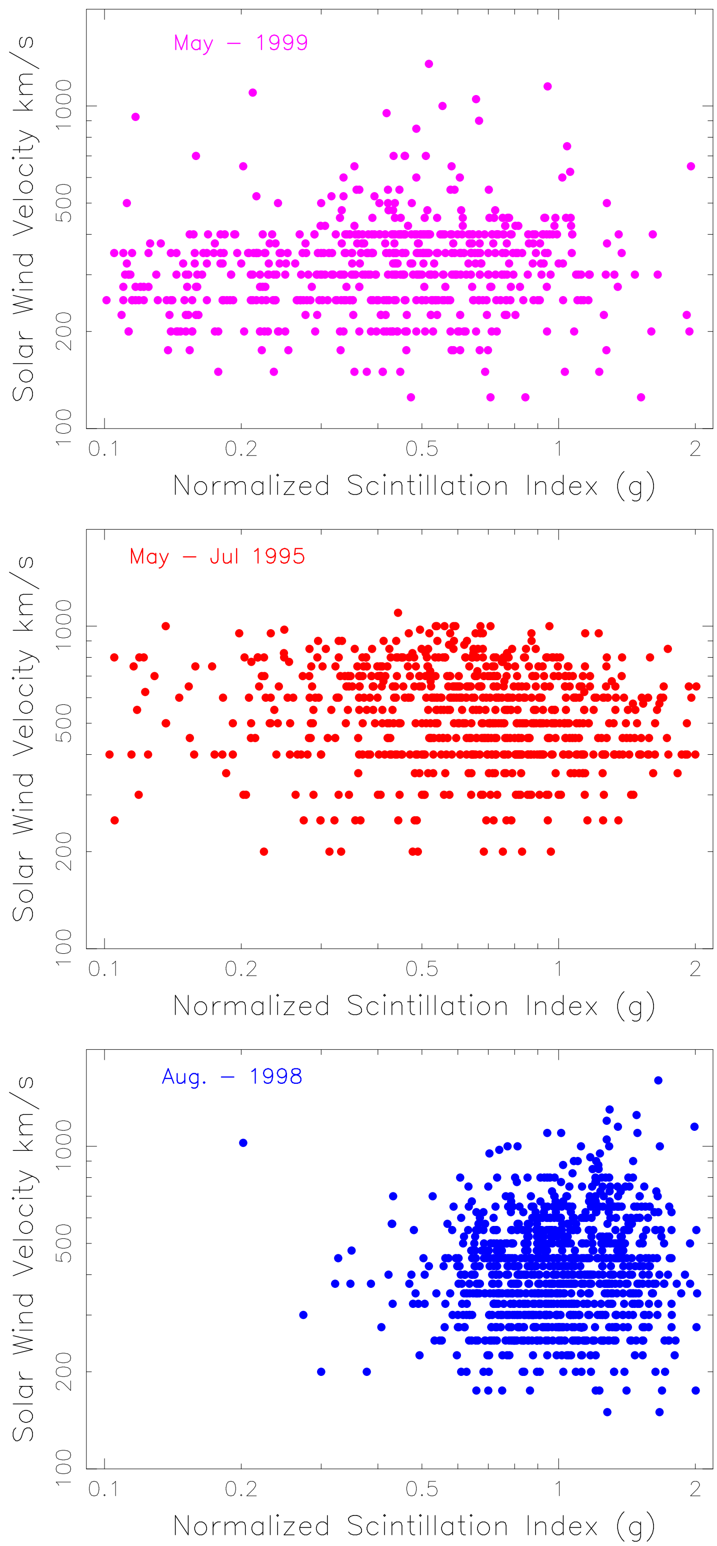

Figure 3. Histograms of g values for each day of observation. The histogram of the 11th clearly shows a much steeper drop in densities with around ∼95% of the sources being observed with g-values less than 0.6

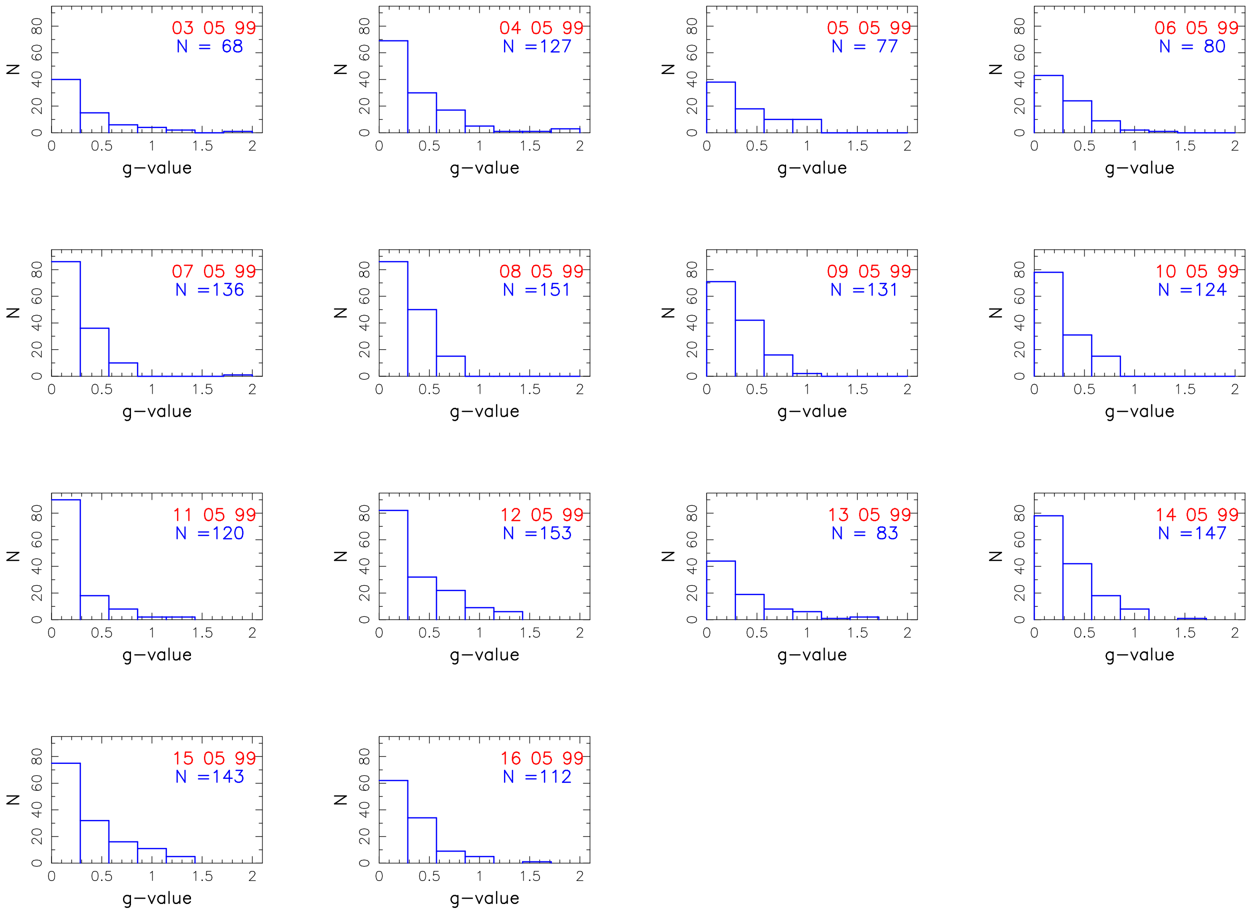

Figure 4. Proton densities from ACE SWEPAM recorded between 1–17 May 1999. Each point represents an hourly average of the recorded densities.

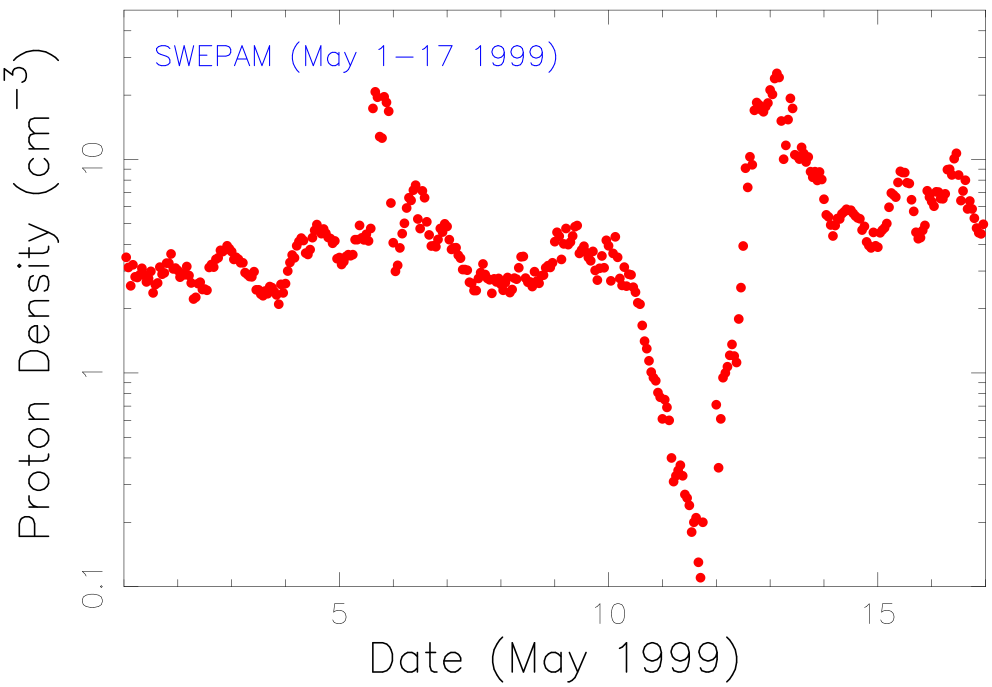

Figure 5a. Plots of g-values Vs date of observation for sources that showed a clear dip in g's on and around the 11th May 1999. The helio latitude, helio longitude, distance from the sun and source name is shown at the top of each panel.

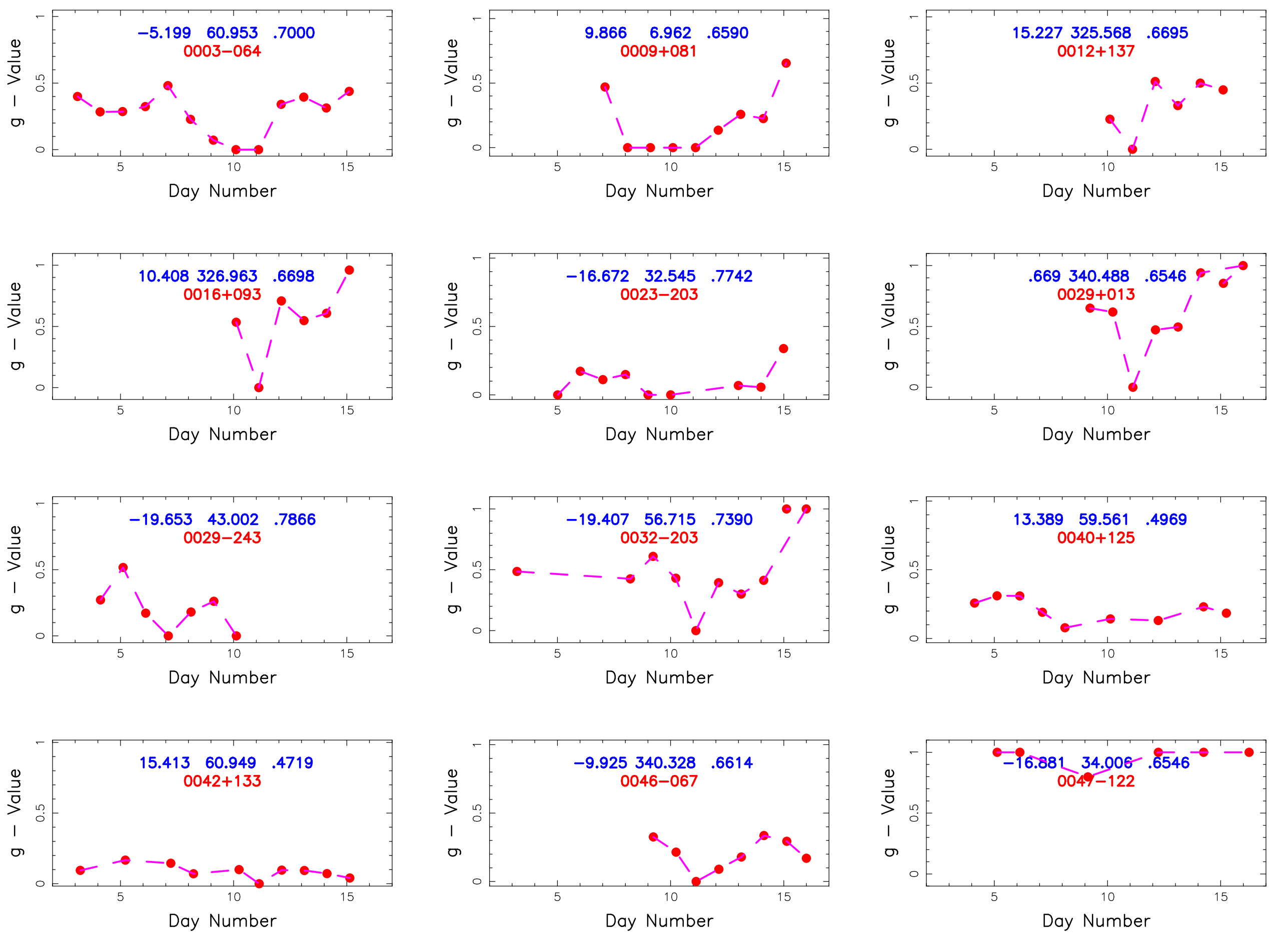

Figure 5b. Plots of g-values Vs date of observation for sources that showed a clear dip in g's on and around the 11th May 1999. The helio latitude, helio longitude, distance from the sun and source name is shown at the top of each panel.

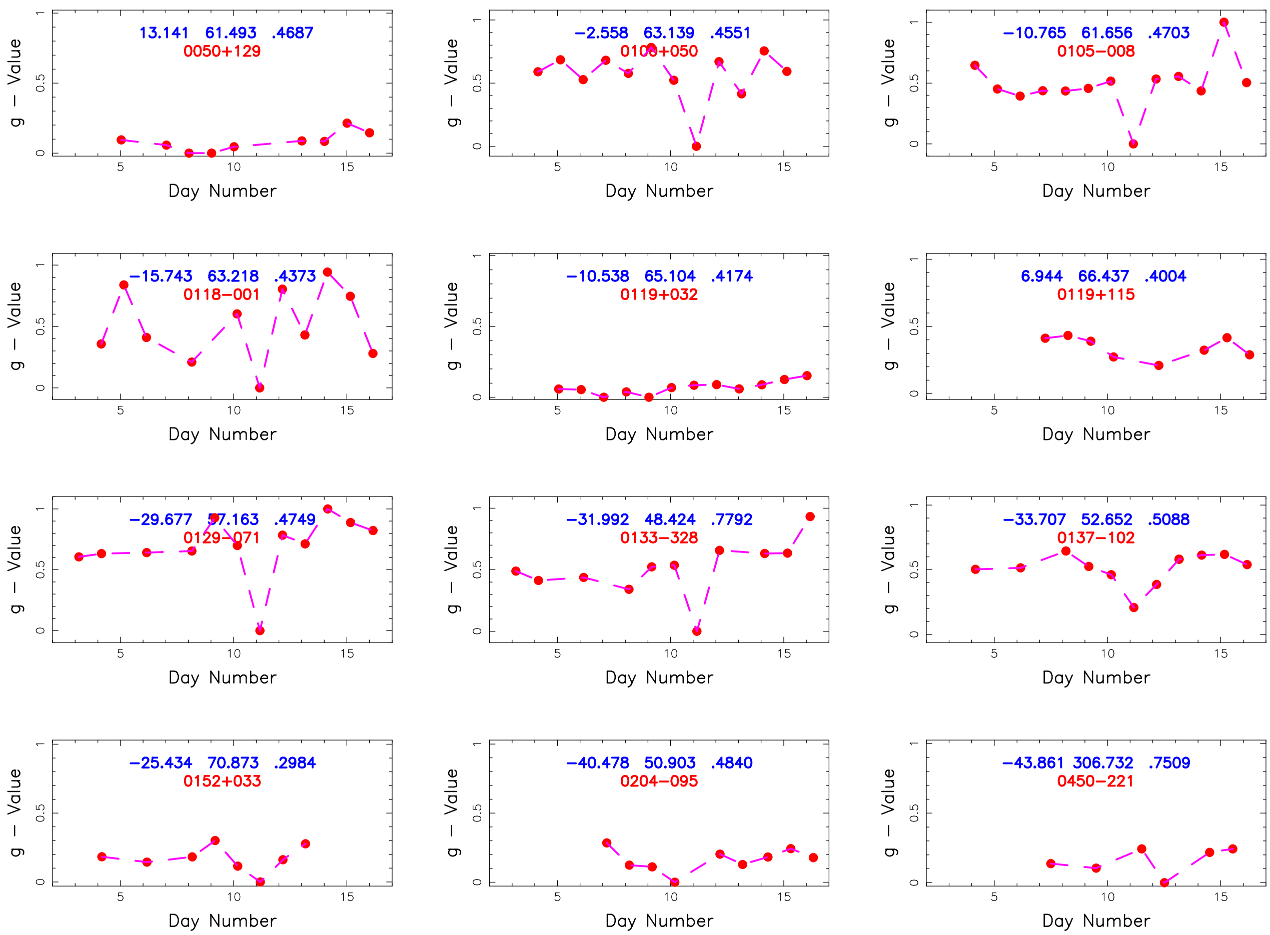

Figure 6. polar plot of the g values for sources that show a steep drop in g values on and around the May 11 1999. The finely dotted circles are circles of equal elongation with the sun at the center. The various ranges of g values are shown by differently coloured symbols, with the small red dots indicating gvalues that became unmeasurably low on or around 11 May 1999. It may be noted that sources adjecent to those represented by the red dots (indicating g=0) are by and large very low (g $\leq$ 0.6) thus indicating a "void-within-a-void" that we postulate.

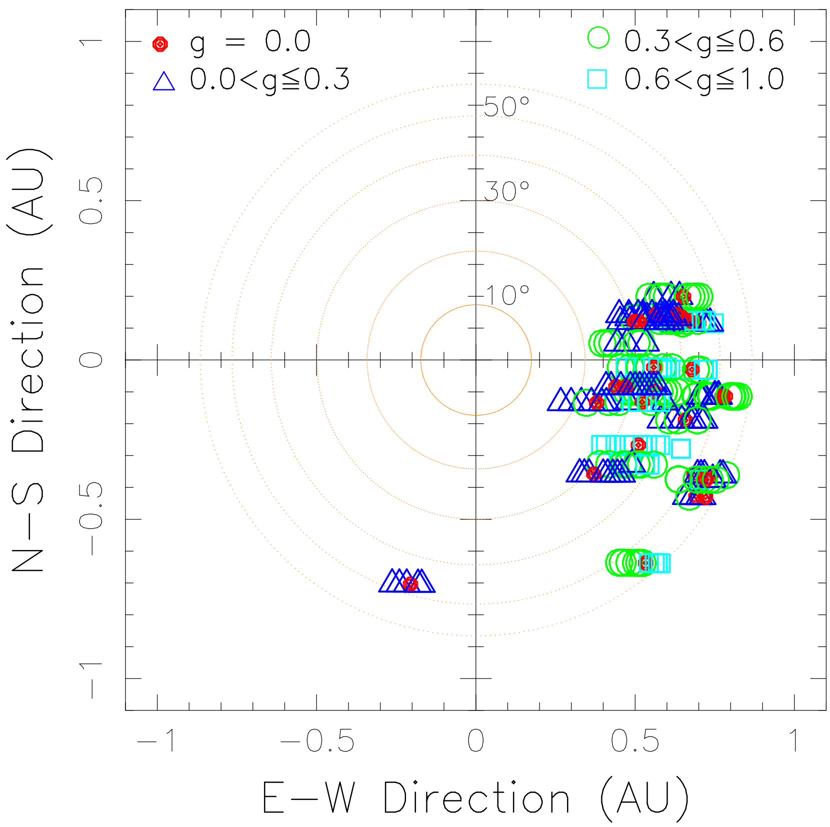

Figure 7. The computed three dimensional structure of the coronal magnetic fields for Carrington Rotation 1949. The solid line marks the location of the HCS. The magnetic field lines, coloured differently to distinguish the two polarities, are shown projected on to a source surface at 2.5 $R_\odot$ beyond which the potential field lines are supposed to be radial. In order not to clutter the figure with too many lines, only fields between 5G and 250 G on the photosphere are plotted. The plot is viewed from 240° in Carrington longitude and 30° in heliographic latitude. Note the location of the large openfield region fanning out into the IPM on the West limb.

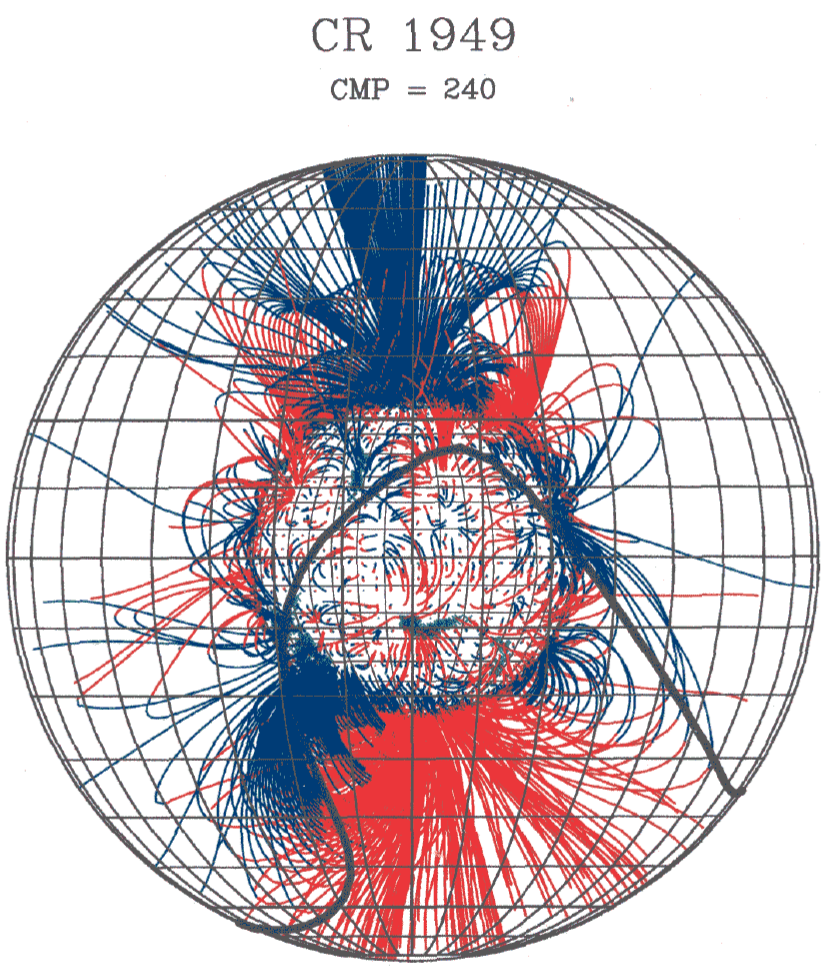

Table 1. Daily Sunspot Numbers between 3 and 16 May 1999

Sunspot Number	**Date (May99)**
80	03
84	04
88	05
104	06
142	07
152	08
149	09
136	10
134	11
122	12
101	13
94	14
105	15
105	16

Annual Mean: 93.3

Table 2. Shows the location and the velocities derived from two-stream IPS spectra between 8 and 13 May 1999.

Date (May '99)	**Time** (UT)	**Elongation** (°E or °W)	**S/N** (db)	**Velocity** ($km\ s^{-1}$)	
8	0715	14 E	25	200	950
8	0840	30 E	20	350	1350
9	0133	17 W	31	300	1050
9	0625	23 W	22	350	1200
10	0129	18 W	31	200	1050
10	0947	39 E	22	250	1000
10	2314	75 W	18	400	1500
12	0450	15 W	19	250	1100
13	0118	20 W	24	300	1250