Determination sky radio emission Background using radio Jove Telescope

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Abstract

In This paper, sky radio emission background level associated with radio storm burst for the Sun and Jupiter is determined at frequency (20.1 MHz). The observation data for radio Jove telescope for the Sun and Jupiter radio storm observations data are loaded from NASA radio Jove telescope website, the data of Sunspot number are loaded from National Geophysical Data Center, (NGDC). Two radio Jove stations [(Sula, MT), (Lamy, NM)] are chose from data website for these huge observations data. For the Sun, twelve figures are used to determine the relation between radio background emission, and the daily Sunspot number. For Jupiter a twenty four figures are used to determine the relation between radio background emission and diffraction between Sunset and observation time.

تحديد اي جزء من السماء يبعث موجات راديوية خلفية بإستخدام مرصد راديو جوفا

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الخلاصة

في هذا البحث, تم تحديد الانبعاث الراديوي نسبة إلى النبضات الراديوية المنبعثة من الشمس وكوكب المشتري بتردد مقداره (٢٠.١) ميغاهيرتز. وان الارصادات الراديوية للشمس ولكوكب المشتري تم الحصول عليها من الموقع الالكتروني لوكالة ناسا الفضائية. أما بالنسبة إلى بيانات عدد البقع الشمسية فقد تم الحصول عليها من مركز البيانات الجيوفيزيائية الدولية. وتم إستخدام محطتين للإرصادات الراديوية المنبعثة من كوكب المشتري وهما: (Sula,MT), (Lamy,NM)
بالنسبة للشمس تم استخدام ١٢إرصادا" لحساب العلاقة بين الانبعاث الراديوي والحسابات اليومية لعدد البقع الشمسية, أما بالنسبة لكوكب المشتري فتم اختيار ٢٤ إرصادا" لإيجاد العلاقة بين الانبعاثات الراديوية والفرق بين وقت غروب الشمس ووقت الرصد للمشتري .

1.Introduction

The Sun was one of the first objects studied by early radio astronomers. It is not as powerful an emitter of radio waves as many other objects, but its close proximity to us makes it appear radio-bright to us here on the third planet. In the year 2000, the Sun is expected to peak in sunspot number and the related solar activity level. That means there should be lots of solar flares on the Sun's surface and the Earth should receive a number of geomagnetic storms as a result. In other words, this should be an exciting time to begin monitoring the Sun with radio receivers and magnetometers[1].

The solar burst shown in Figure1, was recorded at 20.1 MHz with very simple equipment on June 10, 2000 by Wes Greenman, engineer of the University of Florida Radio Observatory. He used a (Radio Jove) receiver and dual dipole antenna to record the solar burst which appears as the prominent hump on the left side of the chart. The stair-stepped signal on the right side of the chart is a calibration signal Solar radio bursts are classified as follows[1]:

1. Type I Short, narrow band events that usually occur in great numbers together with a broader band continuum. May last for hours or days.

2. Type II Slow drift from high to low frequencies. Often show fundamental and second harmonic frequency structure.

3. Type III Rapidly drift from high to low frequencies. May exhibit harmonics. Often accompany the flash phase of large flares.

4. Type IV: Flare-related broad-band continua.

5. Type V: Broad-band continua which may appear with III bursts. Last 1 to 2 minutes, with duration increasing as frequency decreases.

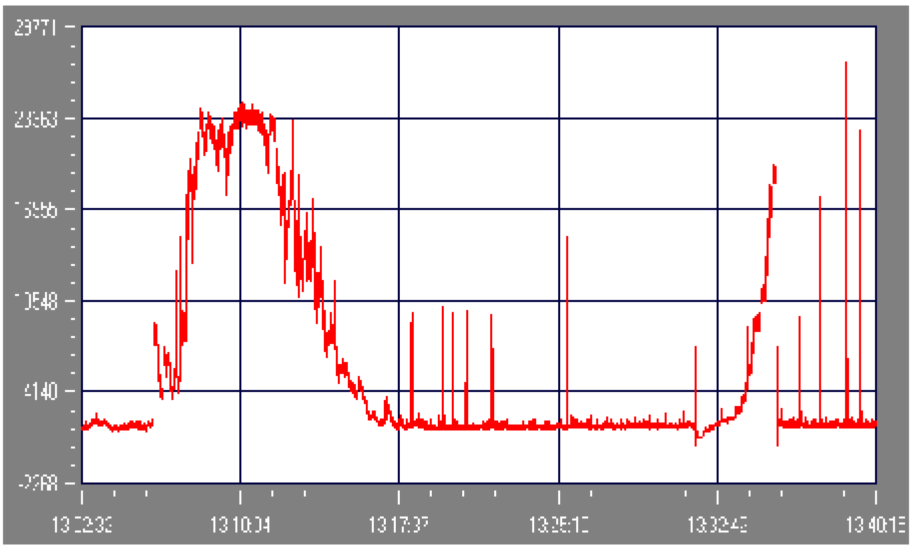

Figure (1): The solar burst with frequency about (21.1 MHz) [1].

2- Radio emission background radiation

The story begins in 1933 with Jansky's discovery of the radio emission from the Galaxy. It was immediately apparent that, on large angular scales, the radio sky is dominated by diffuse Galactic emission. As well known, this great discovery caused little stir in the astronomical community and it was only after the Second World War that the nature and origin of the radio background emission became the object of astronomical interest[2].

By the late 1940s, the emission mechanism was identified as synchrotron radiation and, at about the same time, the first of the discrete radio sources was identified. At that period, one of the principal motivations for attempting to extract the diffuse extragalactic component of the radio background radiation was related to the question of the distances and luminosities of the discrete radio sources which continued to be discovered as the sky surveys discovered more and more faint sources[2].

3-Jupiter radio emission

At the beginning of 1955, Burk and Franklin[3]. discovered, on a frequency f=22.2 MHz, a new discrete radio source whose coordinates vary with the time. The observations made led to the identification of the new radio source with the planet Jupiter, in as much as the position of the source coincides with the position of Jupiter and moves with it across the sky[4,5]..

The radio emission from Jupiter has a sporadic nature, it consists of a series of short bursts, the duration of an individual burst being 10^{-2},10^{-3} sec. In addition to these short radio-frequency pulses, longer pulses were also observed, the duration of which is of the order of 2-3 sec. A considerable number of bursts occur in pairs or triplets with time intervals between bursts of about a quarter of a second or about a tenth of this value[4,5].

The emission occurs in episodes called "storms". A storm can last from a few minutes to several hours. Three types of bursts can be received during a storm. The L-bursts (L for long) that very slowly in intensity with time and the S-burst(S for short) or milli-second bursts which are sporadic spikes and N-burst (N for Narrow band). Sometimes all the three types of burst are present simultaneously[6].

The probabilities of detecting the emission depend strongly on the values of the Jovian central meridian longitude (CML), the Io Phase, and the Jovicentric declination of the Earth (DE) .Lambda III is the System III longitude (CML = Central Meridian Longitude) of Jupiter facing the Earth (0 degrees mean CML is facing Earth). The Io Phase is the angle of Io, with respect to the line of Jupiter and Earth (0 degree means Jupiter, Io and Earth are in one line). The regions in the CML-Io phase plane that have increased probabilities of emission are called sources. The sources are named Io-A, Io-B, and Io-C for the Io- controlled emission and A, B, and C for the Non-Io controlled emission. Jupiter rotates once every 10 hours and the cone rotates with it like a lighthouse beam. To catch a radio storm we have to know when Earth will be aligned with the edge of the cone and when Io is in the right position to pour electrical energy into the storm zone. This will happen a few times in the weeks ahead**.** The radio emission from Jupiter can be shown in Figure 2 [6].

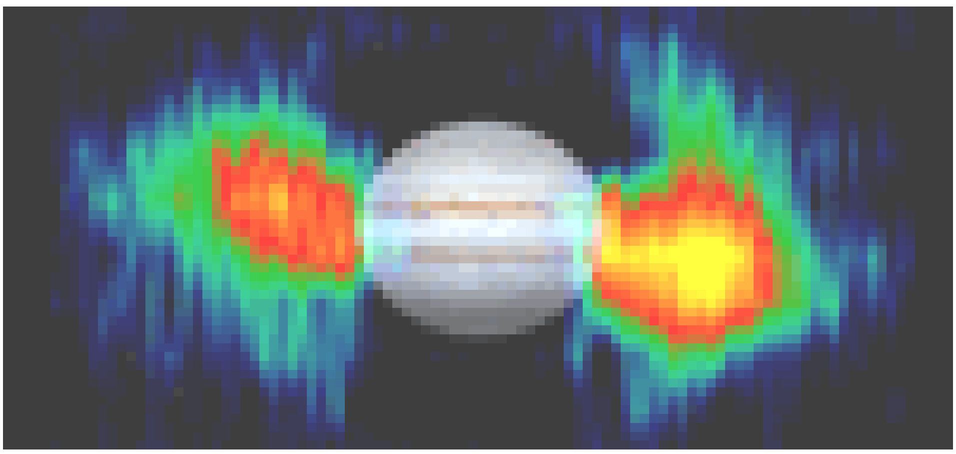

Figure (2): The radio emission from Jupiter

4-Data collection and analysis

The data has been loaded from the Radio Jove Data archive observed for station Sula, MT, USA in 2004 in longitude about (-114.0), latitude about (45.9), Lamy, NM, USA in 2004 in longitude about(-105.53), latitude about(35.29). In frequency about (20.1) MHz, by receiver (RJ 1.1) and antenna (JOVE &double vertical Moxon) and the data of daily sunspot number taking from National Geophysical Data Center (NGDC) [7].

In any radio observations there is a background emission level is associated with actual observations data. In This paper two types of observations data are selected, Sun burst and Jupiter burst observations. Data analysis steps are carried out on the curves of data observation. This analysis is produced data which are plotted in curves, these curves are explained mathematic relations for background behavior.

4.1 Determination of Sun observation

In order to determine the background level from Figure3, we must draw a horizontal average line as shown in the figure, line(T) which is represented the practical background average. For evaluation to this practical line, the following steps are carried out:

Step1: For determined the vertical Y-axis divisions for Figure3, we subtract T1 from T2 as follows:

$T2-T1=8\times1000=80000\ k^{\circ}$ ………………(1)

Where:-

T1 represents the first temperature equal ($8k^{\circ}$).

T2 represents the second temperature equal ($88k^{\circ}$).

Step2: Divide the value from step (1) by the number of (22) which is represented the length in millimeters between two divisions of Y-axis to get the value of one baseline as follows:

$(80000/22) = 3636\ k^{\circ}/mm$

Step3: Calculate the background average line (T) that's equal the multiplying the value of one baseline by the number of millimeters that lies in the background region as follow:

10mm ……………....(2) Background = 3636k

$=36360k^{\circ}$

Step4: The above steps(1-3)are repeated on the other figures for determination the association background level.

Step5: Arrange the data as shown in Table(1)

Step6: Taken the daily sunspot number for related date of observation, we use the website(**N**ational **G**eophysical **D**ata **C**enter NGDC).

Step7: Plot the background level against sunspot number as shown in Figure4.

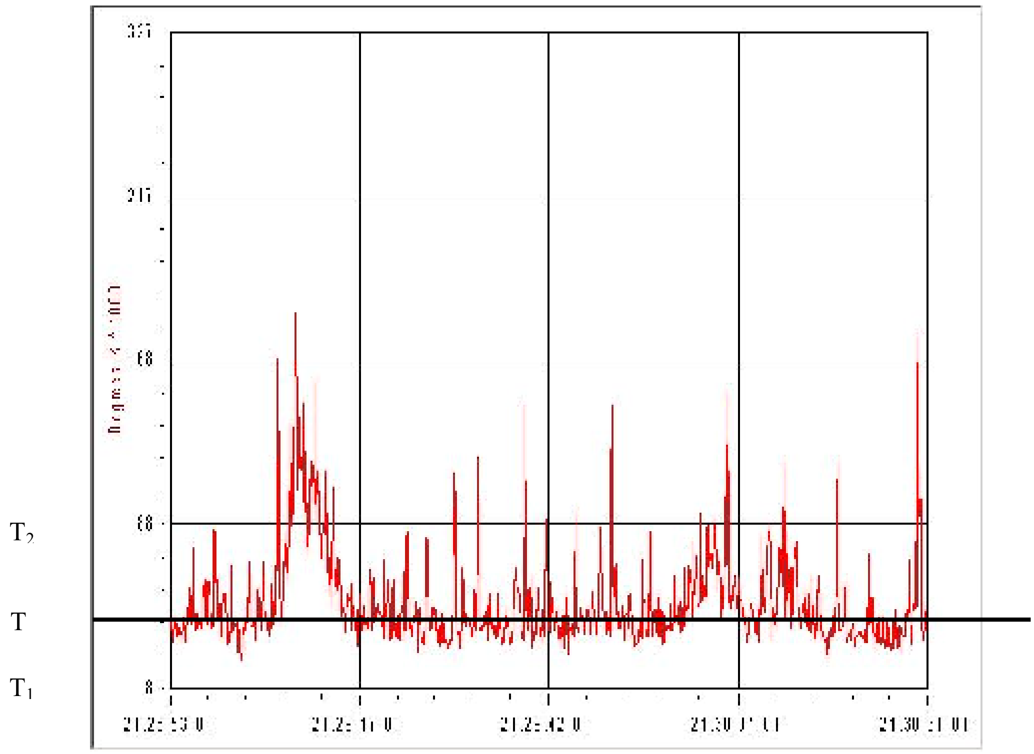

Figure (3) The observation of the sun burst in (18/8/2004) [8].

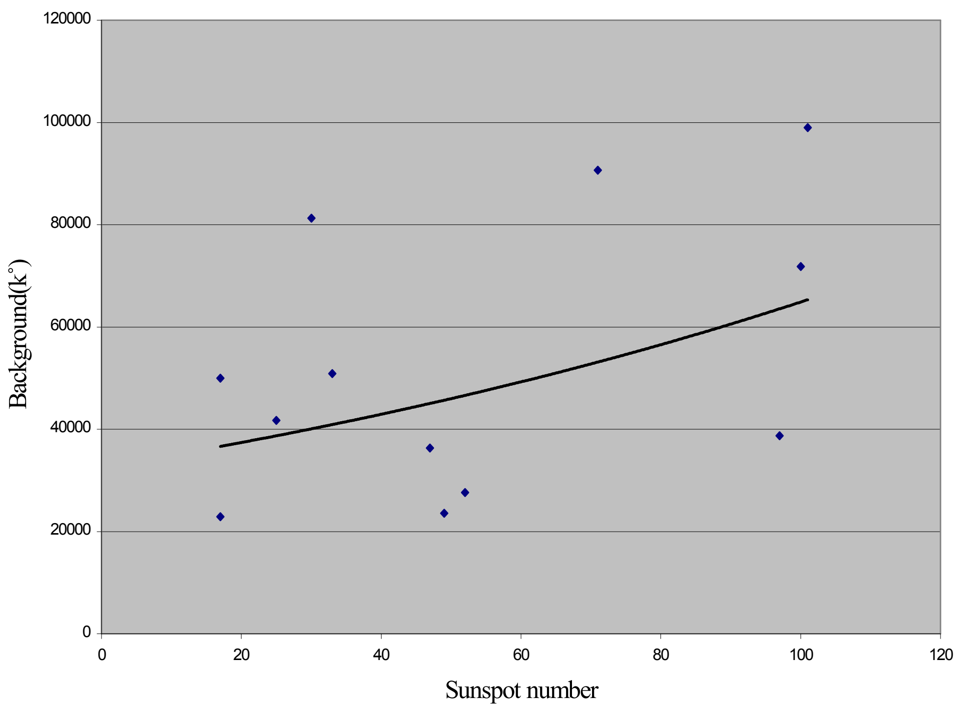

Figure (4): The relation between the background and sunspot number.

Table (1): The observation of the radio bursts of the sun

Date of observation	Background(K°)	Time of observation(U.T.)	Sunspot number[7]
02/12/2004	50913	14:38:06	33
31/12/2004	41733	14:41:33	25
06/11/2004	90680	15:42:57	71
03/10/2004	81270	18:14:11	30
24/10/2004	99000	13:58:48	101
26/10/2004	71816	18:54:44	100
30/10/2004	38744	13:39:48	97
13/09/2004	23545	22:15:56	49
26/09/2004	50000	18:44:37	17
17/08/2004	27632	11:56:33	52
18/08/2004	36360	21:28:53	47
30/08/2004	22908	19:17:19	17

4.2 Determination of Jupiter observation

The Jupiter burst observations are also included background radio emission, this background reduces when the time of observation is far away from sunset time, therefore, it has been taken set of observation from Radio Jove data website. The previous steps are applied on the all Jupiter observation data curves. For arrangement Table2 for station (Sula ,MT, USA), Table3 for station (Lamy, NM,USA).

The Sunset time measured from "Radio Jupiter Pro Jove Edition Software" by relate to the date of bursts observation, Figures 5 and 6 are showing the observation events of the Jupiter burst in Sula, MT and Lamy, NM, respectively.

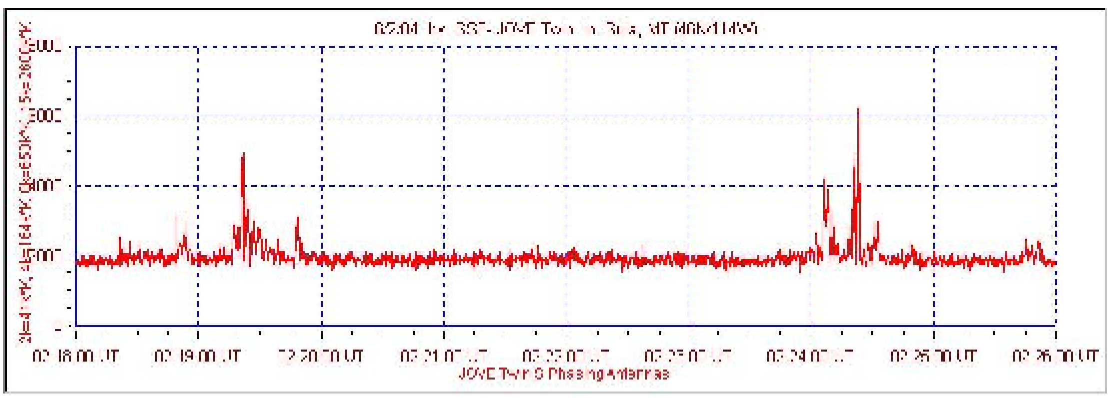

Figure (5): The observation of the Jupiter burst in Sula.MT in (2/6/2004) [8].

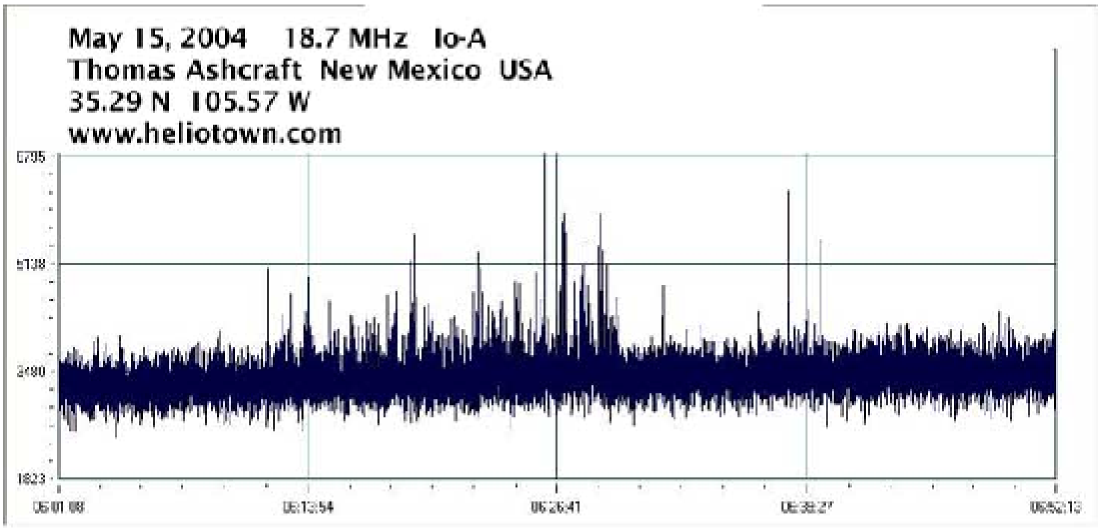

Figure (6): The observation of the Jupiter burst in Lamy, NM,USA in (15/5/2004) [8]

Table (2): The observation by Sula.MT location

Date	Background (K°)	Time observation (UT)	ΔT=Sunset-time of observation(sec)
05/01/2004	1375	14:26:00	03:17
22/01/2004	1500	11:29:00	06:57
25/03/2004	2000	03:25:00	04:11
26/03/2004	1300	03:55:00	03:58
02/04/2004	1375	04:19:00	03:28
24/04/2004	1800	04:22:00	03:59
04/05/2004	1375	00:33:00	07:59
02/06/2004	1800	02:18:00	06:58

Table (3): The observation by Lamy, NM, location

Date	Background (K°)	Time observation (UT)	ΔT=Sunset-time of observation(sec)
28/02/2004	3425	09:00:00	09:51
07/03/2004	2866	06:22:00	12:36
08/03/2004	3068	07:52:45	11:07
12/03/2004	3152.6	04:53:22	02:54
15/03/2004	3221.2	04:30:40	02:57
16/03/2004	2994.5	07:51:25	11:55
21/03/2004	3029.8	04:24:44	02:58
23/03/2004	3022	08:07:59	11:59
24/03/2004	4630	05:30:00	01:58
30/03/2004	3350	08:22:44	11:59

01/04/2004	3107.6	04:56:40	02:56
09/04/2004	3692.4	04:54:17	02:57
15/04/2004	3002	04:16:25	03:13
17/04/2004	3297.8	03:42:28	03:58
01/05/2004	3415.6	04:41:21	03:01
15/05/2004	3148.6	06:01:08	01:52

5- Discussion and Conclusions

a) For Sun observation, the association background level is directly proportional with daily Sunspot number. The relation between background and daily sunspot number can be represented from Figure 4 . This representation can be shown in equation 3.

$$\text{Background}=Be^{K(SSN)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where:
B is constant = 329
K is constant = 0.0069
SSN represents daily Sunspot number.

The equation (3) is chose according to the smallest displayed R-squared value for curve fitting process (R^2 =0.18). Therefore Figure 4 is concluded two important points , first the behavior of background level is exponential against the daily Sunspot number , and the second the background level is increased when the Sunspot number increased.

b) For Jupiter observation, the background association with Jupiter observation is inversely proportional with time difference between Sunset and observation time . This can be explained from Figures 7 and 8 when the data are represented by equation 4 and equation 5 respectively and as follows:

$$\text{Background}=B_1\Delta T+C_1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where:
B_1 is constant=-8.4655.
ΔT= represents the difference time between Sunset and observation time.
C_1 is constant= 1444.

$$\text{Background}= B_2\, e^{C_2\Delta T} \qquad \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

Where:
B_2 is constant=1181.8.
ΔT represents the difference time between Sunset and observation time.
C_2 is constant=-0.3676.

The R-squared value of equation(4) and equation(5) are assigned R_1^2=0.004, R_2^2=0.08, respectively. The explanation of these curves are that the background level radio emission becomes low effect when the observation time is far away from the sunset time. .

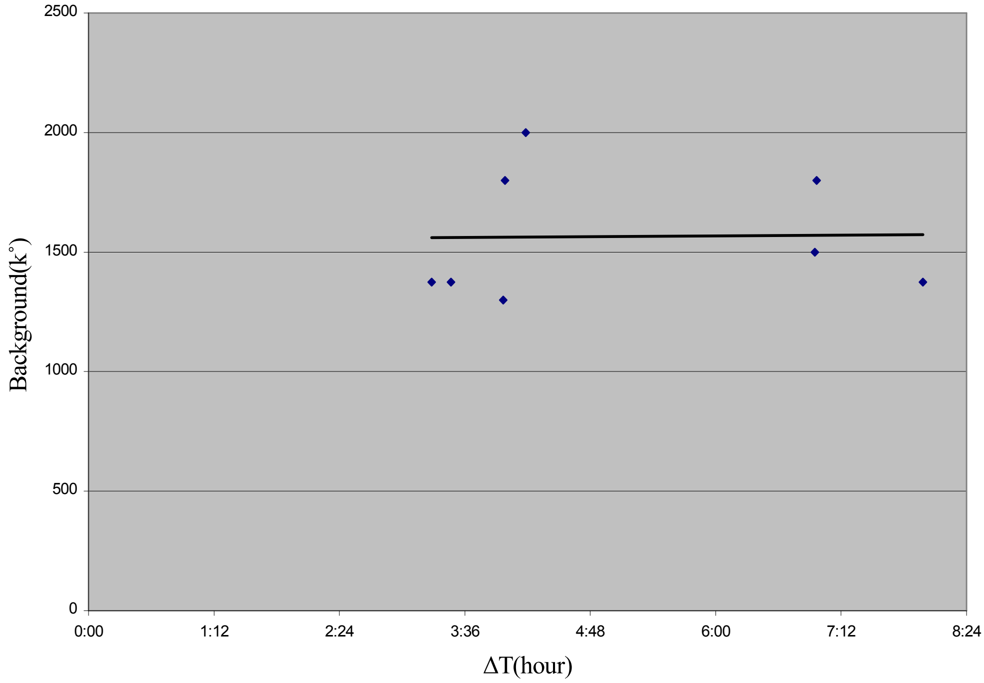

Figure (7): The relation between the background and the ΔT where Background= $B_1\Delta T+C_1$

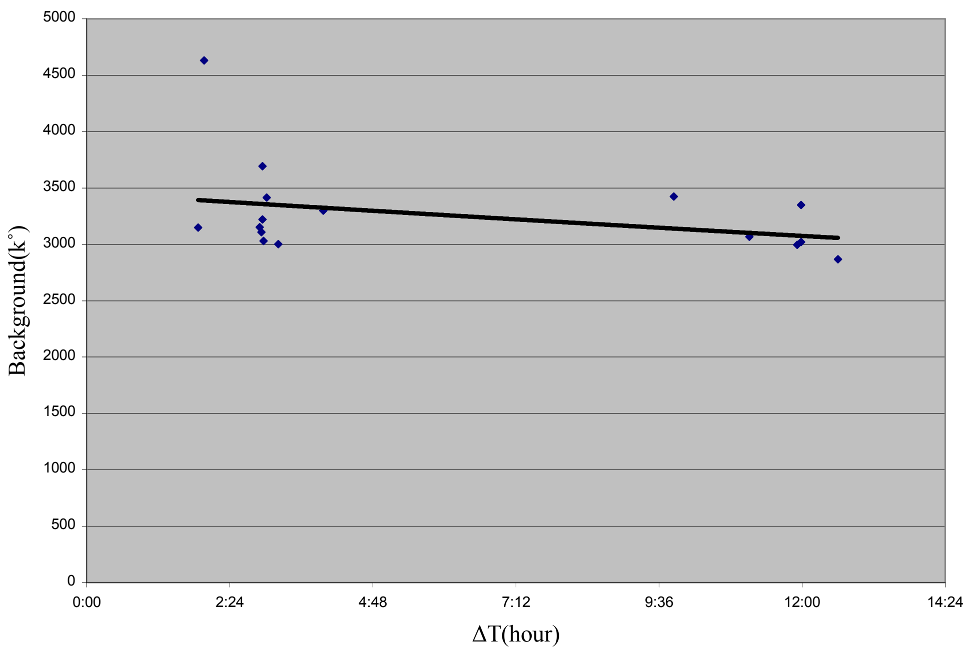

Figure (8): The relation between the background and the ΔT where Background= $B_2\, e^{C_2 \Delta T}$

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