

From: <suchida@mvc.biglobe.ne.jp>
Date: Fri, 1 Jul 2005 17:36:41 +0900
Subject: [DSLFF] Conversion from mg/arcsec^2 to cd/m^2
Reply-To: DarkSky-list@yahoogroups.com

Does anyone have conversion table or converting formula from mg/arcsec^2 to cd/m^2 and vise versa.

Reading all comments on mg and cd for the last two weeks, I am beginning to agree that cd/m^2 is preferred value for mutual understanding of night sky quality among concerned people, and to share related issues. If we can simply convert mg/arcsec^2 to cd/m^2 we can share quite a few measurements already done by many people.

One such example of convenience is that some astronomers suggested the following table for sky quality assessment in mg;

Limiting mg	Approximate Sky Brightness in mg/arcsec^2
6	20
5	19
3	17

I wish I have these numbers in cd/m^2 too, then I can show this to lighting designers for their better understanding of the situation of urban sky glow and etc.

Jan Hollan wrote;
> read. Even more so with a value like ``one fourth of a millinit'', which
> is representative for natural moonless clear sky night luminances in
> zenith.

Judging from Jan's comment I can do it by myself as follows;

cd/m^2	approximate mg/arcsec^2
0.00025	22 (brightness of natural dark sky)
0.0016	20

Well, this looks not good at all and I do need exact conversion table and formula to complete this.

Shigemi

From: Jan Hollan <jhollan@amper.ped.muni.cz>
Date: Fri, 1 Jul 2005 13:18:58 +0200 (CEST)
Subject: [DSLRF] Conversion from mg/arcsec^2 to cd/m^2
Reply-To: DarkSky-list@yahoogroups.com

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Shigemi, the formula can be, e.g., found from the code of my programme
fai2bri. The link is given at the bottom of my php answer, the link
being
<http://astro.sci.muni.cz/pub/hollan/programmes/sources/astro/lum.pas>
the php text being
<http://amper.ped.muni.cz/jenik/astro/lum.txt>
and the working php being
<http://amper.ped.muni.cz/jenik/astro/lum.php>

Natural sky luminance in zenith is not equivalent to a star with faintness
of 22 mag defocused to one square second. It's brighter. If you give 22
mag as an input to my programme, it says

```
compute
22___ [mag__]
If the unit is one magnitude, it applies to a star of that faintness,
covering (defocused) a solid angle of:
[one square_____] __ [s]

[ ] save settings    [ ] use my saved settings

Another option is to use your own command line (ev. [ ] overriding all
previous data):
```

(`?' gives help). compute

The equivalent of Luminance expressed by a star of faintness of
22.00 mag defocused to "one square second"
means a Luminance of some

1.71E-4 cd/m^2

Vice versa, if you give ``one fourth of a millinit'' as an input somehow
(no way to ask this way the programme, to get a similar speech-based
answer), you get (the last digit is missing in the input box after
computation):

compute

0.0002 [cd/m²]

If the unit is one magnitude, it applies to a star of that faintness, covering (defocused) a solid angle of:

[one square_____] __ [s]

[] save settings [] use my saved settings

Another option is to use your own command line (ev. [] overriding all previous data):

(`?' gives help). compute

The given Luminance of

2.50E-4 cd/m² corresponds to a star of

faintness of some

21.59 mag defocused to one "square second",

Anyway, what's the base of my message:

mg/arcsec² is a sheer nonsense.

No less one, than dB/m².

If we would like to be taken seriously, we have to express ourselves as if being not entirely crazy. Unfortunately, it seems we are not even able to pretend to be sane. What a pity for the night environment. We should try once more.

jenik

From: <suchida@mvc.biglobe.ne.jp>
Date: Sun, 3 Jul 2005 01:24:43 +0900
Subject: [DSLFF] Re: Conversion from mg/arcsec^2 to cd/m^2
Reply-To: DarkSky-list@yahoogroups.com

Hello Jan,

Thanks for the URL and its conversion programme "Luminance".

I did some calculations using your Luminance at;
URL: <http://amper.ped.muni.cz/jenik/astro/lum.php>

Then their results are shown in an excel table at;
<http://www2a.biglobe.ne.jp/~wakaba/lp/Test%20Conversion%20Table.xls>

In the bottom of Excel table I did calculate the surface luminance of SUN by using data from astronomical almanac. The luminance of SUN is $2.02E+09$ cd/m² and it is close to the results from "Luminance" which is $1.85E+09$, but about 10% difference. This small difference maybe caused by the difference in diameter of SUN.

The Luminance gave me the following results for the SUN.

The equivalent of Luminance expressed by a star of faintness of
-26.74 mag defocused to a circle of angular diameter of 32.0 minutes
means a Luminance of some
 $1.85E9$ cd/m²

I hope I used the Luminance correctly!

By the way if possible and when you have time, can you describe and show us the conversion formula in plain text? I am not familiar with the programming language and cannot follow how the calculation is made.

Thanks anyway it is your great work!

Shigemi

From: Fabio Falchi <fabio_falchi@yahoo.it>
 Date: Tue, 5 Jul 2005 16:47:19 +0200 (CEST)
 Subject: [DSLFL] Re: Conversion from mg/arcsec^2 to cd/m^2
 Reply-To: DarkSky-list@yahoogroups.com

The formulas for the conversions can be found at:
<http://dipastro.pd.astro.it/cinzano/libro/node63.html> (see below from InternetArchive)

Fabio Falchi

Magnitudini

Una unità di misura molto usata per esprimere la brillantezza del cielo è la magnitudine per unità di area angolare. Essa si può riferire ad un grado quadrato o ad un secondo d'arco quadrato. Poiché un grado è pari a 3600 arcsec sarà:

$1 \text{ grado}^2 = 1.2960 \cdot 10^7 \text{ arcsec}^2$. Quindi la brillantezza di un arcsec quadro sarà meno luminosa di quella di un grado quadrato per un fattore $1.2960 \cdot 10^7$ che corrisponde, nella scala logaritmica delle magnitudini ad una differenza di magnitudine di 17.78.

Riassumendo: $b[\text{mag/deg}^2] = b[\text{mag/arcsec}^2] - 17.78$.

(62)

$$V [\text{mag arcsec}^{-2}] = 41.438 - 2.5 \log_{10} b [\text{ph cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}]$$

Le formule di passaggio tra la brillantezza misurata con le unità fotoniche e le magnitudini^[1] nelle bande B e V sono state

calcolate da Garstang (1986, 1989):

$$B [\text{mag arcsec}^{-2}] = 41.956 - 2.5 \log_{10} b [\text{ph cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}]$$

(63)

$$V [\text{mag arcsec}^{-2}] = 12.603 - 2.5 \log_{10} b [\text{cd m}^{-2}]$$

(64)

Dalle precedenti si ottengono, con le relazioni della sezione precedente, le seguenti formule di

passaggio tra unità fotometriche e magnitudini:

$$V [\text{mag arcsec}^{-2}] = 26.346 - 2.5 \log_{10} b [nL]$$

(65)

$$m_{vis} [\text{mag arcsec}^{-2}] = 26.33 - 2.5 \log_{10} b [nL]$$

(66)

Per la banda visuale, vale invece le seguente formula di passaggio (Garstang 1986):

$$m_{vis} [\text{mag arcsec}^{-2}] = 12.59 - 2.5 \log_{10} b [\text{cd m}^{-2}]$$

(67)

da cui si ricava:

Pierantonio Cinzano 3/12/1998

[1]...misura

Per una descrizione del metodo per ricavare l'estinzione e correggere le misure ottenute si veda più avanti, oppure il lavoro di S. Foti e S. Cristaldi *Studio dell'inquinamento luminosocielo nella zona di Catania* (Foti 1992).

From: <suchida@mvc.biglobe.ne.jp>
Date: Thu, 7 Jul 2005 17:04:40 +0900
Subject: [DSLFF] Re: Conversion from mg/arcsec² to cd/m²
Reply-To: DarkSky-list@yahoogroups.com

Hello Fabio and Jan,

> The formulas for the conversions can be found at:
> <http://dipastro.pd.astro.it/cinzano/libro/node63.html>
>
> Fabio Falchi

Thank you both of you! It is very clear to me now. Both URL's give me the same calculated data. I understand the reference is defined somewhere as standard between cd and mg such as $1\text{cd/m}^2 = 12.59\text{mg/arcsec}^2$ or at some other point. I want to use constant of 2.51 instead of 2.5 since it gives a little better resolution.

Clear Skies,

Shigemi

From: Jan Hollan <jhollan@amper.ped.muni.cz>
Date: Thu, 7 Jul 2005 22:54:39 +0200 (CEST)
Subject: [DSLFF] Re: Conversion from mg/arcsec² to cd/m²
Reply-To: DarkSky-list@yahoo.com

> calculated data. I understand the reference is defined somewhere as
> standard between cd and mg such as 1cd/m² = 12.59mg/arcsec² or at some
> other point. I want to use constant of 2.51 instead of 2.5 since it
> gives a little better resolution.

Shigemi,

there are two numbers which are close, but are not the same. They are close just accidentally.

2.511886... = 10^{2/5} is the brightness ratio of two stars differing by 1 mag.

2.5 exactly is the coefficient to get faintness difference (in magnitudes) from the decadic logarithm of brightness ratio (neglecting the sign).

2.5 log(10^{0.4}) is identical to 1 log(10), i.e. to 1.

2.5 log(2.51) is almost equal to 1.

In fact, 2.51 is quite close to 2.72 (e) as well. The consequence is that if two stars differ by 0.1 mag, then one star is about 10 % brighter than the other one. 2 dmag correspond to some twenty per cent more brightness.

Another theme, an example of real luminances:

I've processed three images of Brno sky, made in past days. One of them at an exceptionally clear night, the other ones at a usual one on June 3, when I tried to find comet Tempel. I could not see it. No wonder, as the sky luminance was six millicandles per square metre (6 mnt, six millinits), and the comet sized some 2' had some 10 mag or more, i.e. luminance of just one millinit or less. The images with tabelled and colour-coded luminances are within

<http://amper.ped.muni.cz/light/luminance/tempel/>

(colour coding is explained in the parent directory; magenta is centered at 0.01 cd/m², with steps equal to 0.5 mag -- five steps comprise 2.5 mag or luminance ratio 10).

(The extinction made the comet still 1 mag fainter in Brno at seventeen degrees over horizon, so the attempt was completely hopeless).

Jenik

From: Doug Welch <welch@physics.mcmaster.ca>
Date: Fri, 15 Jul 2005 08:17:52 -0400
Subject: [DSLRF] Conversion from mags/arcsec^2 to cd/m^2
Reply-To: DarkSky-list@yahoo.com

Folks,

Jan Hollan has pointed out that we used incorrect constant in the conversion equation. The constant in the previous e-mail had been corrected for a 20% atmospheric extinction. Below is the correct relation and some corrected examples.

$$[\text{value in cd/m}^2] = 10.8 \times 10^4 * 10^{(-0.4*[\text{value in mag/sq_arcsec}])}$$

$$\begin{aligned} \text{So a value of } 0.0 \text{ mag/sq_arcsec} &= 1.08 \times 10^5 \text{ cd/m}^2 \text{ and} \\ 20.0 \text{ mag/sq_arcsec} &= 1.08 \times 10^{(-3)} \text{ cd/m}^2 \end{aligned}$$

The Sky Quality Meter will provide usable readings between about

$$\begin{aligned} 6.0 \text{ mag/sq_arcsec} &= 4.3 \times 10^2 \text{ cd/m}^2 \text{ and} \\ 24.0 \text{ mag/sq_arcsec} &= 2.7 \times 10^{(-5)} \text{ cd/m}^2 \end{aligned}$$

The web calculator at
<http://www.unihedron.com/projects/darksky/magconv.php>
has now been corrected for that constant. (You can test it easily by submitting 0.0 for cconversion.)

Best regards,
Doug Welch