Data visualization and distinct features extraction of the comet Ison 2013

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Abstract

The distribution of the intensity of the comet Ison C/2013 is studied by taking its histogram. This distribution reveals four distinct regions that related to the background, tail, coma and nucleus. One dimensional temperature distribution fitting is achieved by using two mathematical equations that related to the coordinate of the center of the comet. The quiver plot of the gradient of the comet shows very clearly that arrows headed towards the maximum intensity of the comet.

Key words

Interaction of Comet, Histogram, data visualization.

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الرؤيا المثالية للبيانات وكيفية استخراج التفاصيل المميزة للمذنب Ison2013

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الخلاصة

دراسة توزيع كثافة المذنب C/2013 Ison من خلال اتخاذ الرسم البياني لها. التوزيع يكشف أربع مناطق متميزة التي لها علاقة مباشرة بالخلفية، الذيل، الهالة والنواة. تم التحقق والتطابق لتوزيع درجة الحرارة لبعد واحد باستخدام اثنين من المعادلات الرياضية التي تتعلق باحداثيات مركز المذنب. تم رسم اللمعان التدريجي للمذنب والذي يظهر بشكل واضح جدا من خلال رأس الاسهم التي تتجه نحو اعضم شدة لنواة المذنب.

Introduction

The solar wind plays an important role in changing the geometry of the cometary ion tail [1]. The interaction between the cometary ion tail nucleus is mainly affected at the new ions added the plasma of the solar wind [2]. Visualizing scientific data helps to complement the narrative of observation or experiment. A number of studies have reviewed the progression and evolution of the field in software engineering and the sciences [3, 4, 5]. High energy physics (HEP) research makes common use of the histogram as a data analysis tool. A great deal of particle physics data, both experimental and phenomenological [6,7,8], is analyzed with histograms. Hubble telescope sees the comet ison–nasa, the Hubble telescope view of comet ison (C / 2012 S1) April 10, 2013, this image was taken invisible light; the blue color was added to Bring out details in the comet image. In 2008 salman Z. Khalaf showed In his research was the study of the interaction between the solar wind and ions comet tail in the present of MHD have been studied. has been achieved using a simulation model lax-wendroff explicit method for three dimentional space[9]. In 2014, Agundezet al. presented molecular observations carried out with the IRAM 30m telescope at wavelengths around 1.15 mm towards the Oort cloud comets C/2012 S1 (ISON) and C/2013 R1 (Lovejoy) when they were at 0.6 and 1 AU, respectively, from the Sun, where HCN, HNC, and CH_3OH was found in both comets, together with the ion HCO^+ in comet ISON and a few weak unidentified lines in comet Lovejoy [10].

Data visualization

The amplitude of given image will be real nucleus the comet Ison 2013 is shown Fig. 1 and its contour plot is shown in Fig. 2. There are two low levels of intensity surrounding the comet Ison and level increases very sharply as we approaching the nucleus. This means that there is sudden changes in temperature near the head of the comet which this change become slight when we moving to word tail.

The probability density function or histogram of an image is a graphical tool that developed by statistician to visualize frequency distribution of the brightness level of an image is stored of such in the computer as number between (0-255). The histogram of such image computed by examining the brightness of each pixels one a time and labeling it into the bucket that corresponding to its brightness level. When we have done this then we count how many pixels are in each bucket and the number of pixels as a function of brightness represents the histogram. This is a result of a quantization that converts a continuous range to a discrete of levels. In the case of optical imaging of the comets, the signal or intensity involve photon counting which implies that the amplitude would be inherently quantized.

Implementation of such process on an image of comet Ison, the histogram consist of four regions as shown in Fig. 3

1- Background region. The level of intensity is between (0-18).

2- Tail of comet region. The level of intensity is between 19-64.

3- Coma region. The level of intensity is (65-190).

4- Nucleus region. The level is above (190-255).

Fig.1: The image of comet C/2012 ISON.

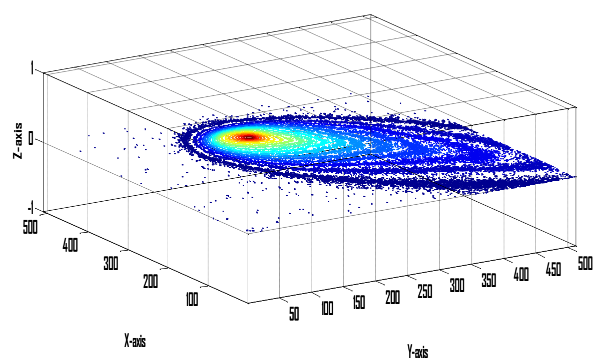


Fig.2: Contour plot of Fig. 1.

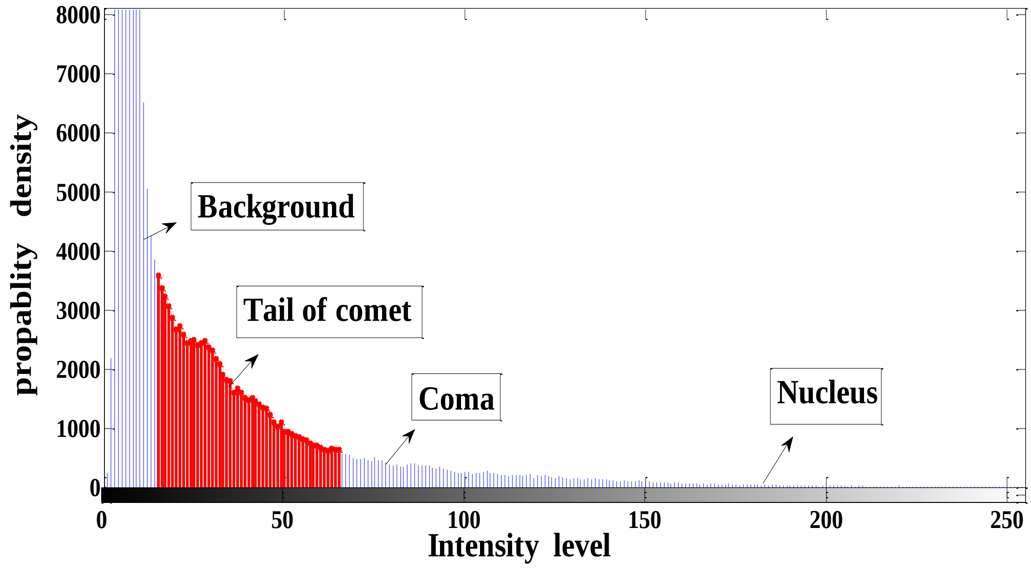


Fig.3: Probability density functions as a function of intensity levels.

Mathematical modeling

The intensity of any optical images is related to the temperature by the Stefan- Boltzmann law[11].

$$F = \sigma T^4 \quad (1)$$

where F is a flux in unit watts/m^2 and σ is Steven Boltzmann constant.

The total luminosity from an object would be

$$L = 4\pi R^2 \sigma T^4 \quad (2)$$

The temperature distribution (T_D) as function of distance is shown in Fig.4. It is so clear that as we are approaching the comet of the nucleus. The mass density is exponentially increasing. It is now so important to look at the transition of the mass density value as a function of distance across section through the comet Ison 2013 that passing through the center of the nucleus Fig.5 demonstrates this cross section as a function of distance and the result. It can be clearly seen demonstrated that there are four transition points in the mass density which matching the regions of the histogram.

It is important to describe the raw data that presented in Fig.4 in terms of mathematical equations. This is done by:

1-The first plot (red plot) represents positive exponential function given by

$$T_D = e^{0.0143*d} \quad (3)$$

where d is the distance of the comet Ison 2013 (let the maximum value of nucleus) Ison 2013 (0<d<387), that located at left of the nucleus as shown fig 5.

2- The second plot (green plot) is a negative exponential function given by

$$T_D = 255/e^{0.03(d-387)} \quad (4)$$

where (255) is a normalization parameter and (387) is the coordinate of the nucleus, i.e., and (d) is the distance that located beyond the maximum value of the nucleus, d ≥ 387. Equation (3) describes (T_D) showed in Fig. 5, as a smooth positive exponential function starting from the beginning of the tail up to the maximum value of the nucleus while Equation (4) represents T_D as an extremely sharp negative exponential function starting from the maximum value of the nucleus to the end of the comet.

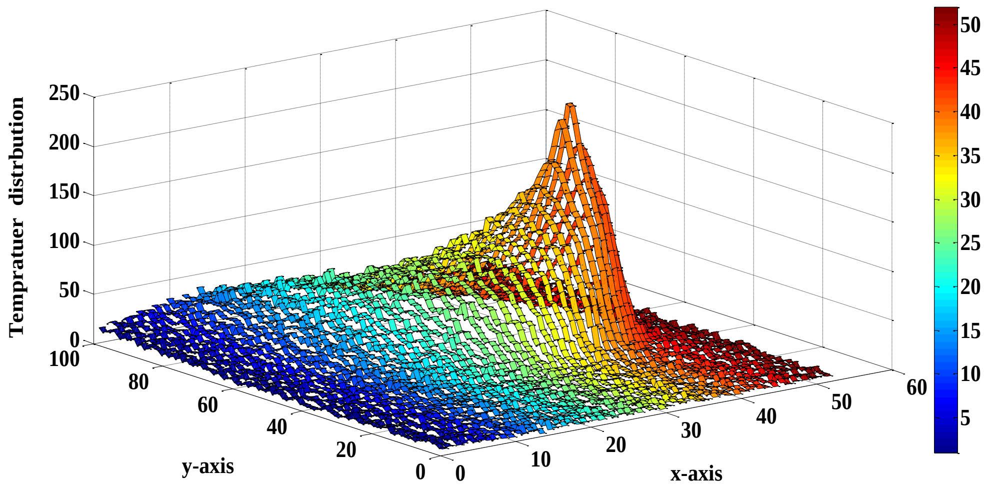


Fig. 4: Perspective plot of (T_D) as a function of plane, distance (x ,y).

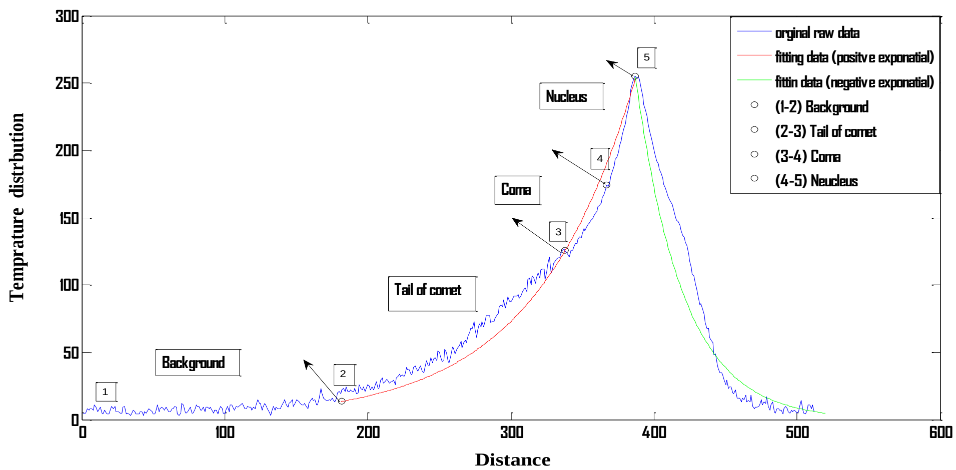


Fig. 5: Cross section through the comet passing the center of the nucleus showing the transition points that local the boundaries of four regions.

Further visualization of the comet Ison 2013 is also demonstrated by plotting the velocity flow of the intensity of the comet. This is done by computing the gradient of the image Ison, i.e,

$$\nabla I = \frac{\partial I}{\partial x} \cdot \frac{\partial I}{\partial y} \qquad (5)$$

This gradient vector represent the partial derivative of an image in the x and y direction[12].

In a continuous from, the above equation could be written as.

$$\frac{\partial I(x,y)}{\partial x} = \lim_{\Delta x \to 0} \frac{I(x+\Delta x,y)-I(x,y)}{\Delta x} \qquad (6)$$

$$\frac{\partial I(x,y)}{\partial y} = \lim_{\Delta y \to 0} \frac{I(x,y+\Delta y)-I(x,y)}{\Delta y} \qquad (7)$$

In a discrete form equation 6 and 7 are written by

$$\frac{\partial I(x,y)}{\partial x} = I(x+1,y)-I(x,y) \qquad (8)$$

$$\frac{\partial I(x,y)}{\partial y} = I(x,y+1) - I(x,y) \quad (9)$$

Combining these equations represent the gradient of an image. The gradient is a vector that demonstrates how quickly the image is charging when we move in either x or y – directions as shown fig(6). The image gradient is important in boundary detection because image often change most quickly at the boundary between objects in an image.

The vector gradient is computed using eight directions as given by the following arrangements.

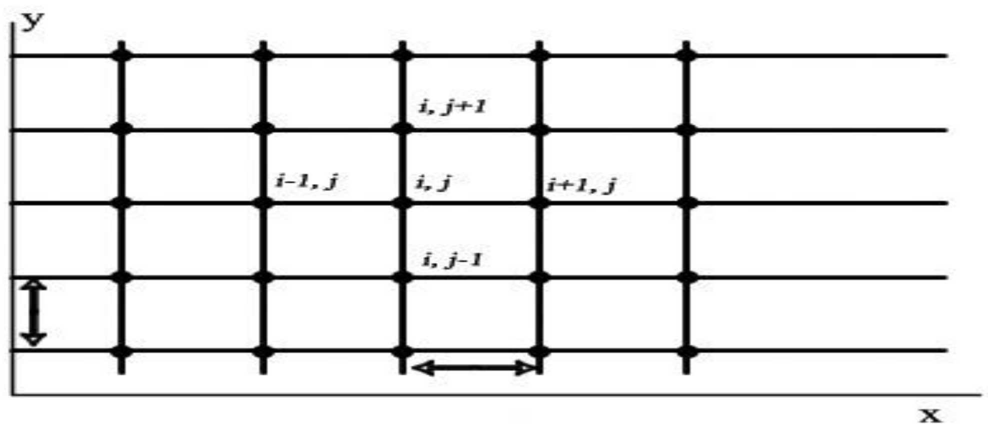
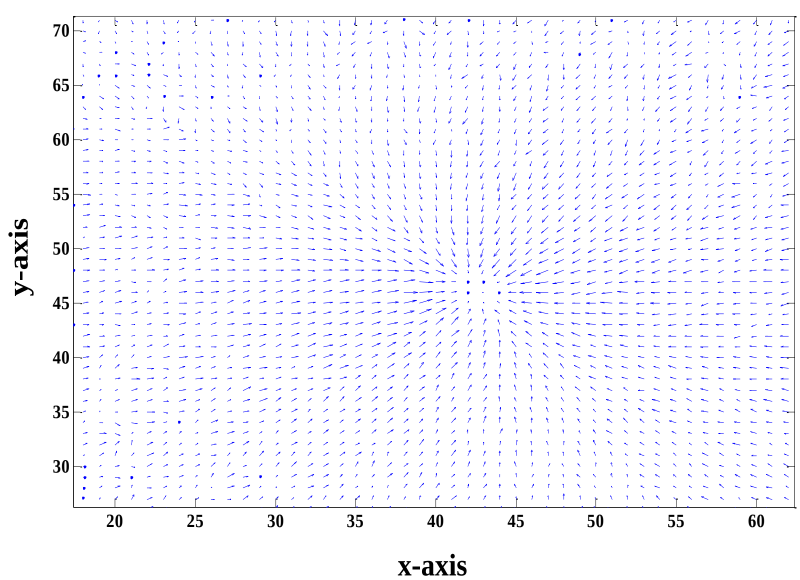


Fig. 6: An example of computational grid.

This vector is represented by an arrow that satisfy the magnitude of the gradient and its direction. The results are shown Figs. (7 and 8).



Fig(7).T$_D$ flow in the center of the nucleus of the comet Ison 2013.

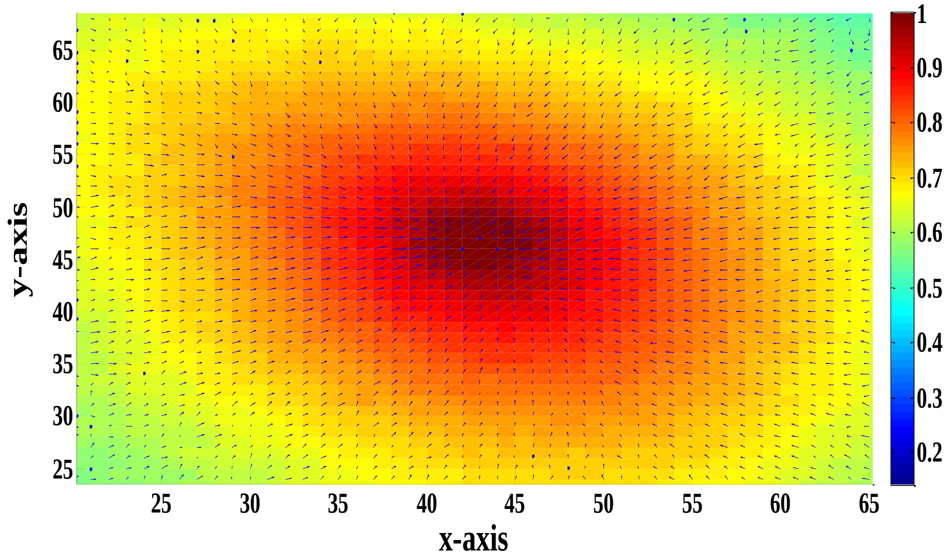


Fig.8: The same as in Fig. 7 but superimposed on the raw data of the nucleus.

As well as the above figure represents the distribution of the movement and direction of the particles of the solar wind with the ion cometary tail toward the center of the comet's nucleus.

Conclusions

We conclude the followings.

1- There are four regions that divided the image of the comet Ison, then regions are clearly visible and identified, they are related to the background, tail coma and nucleus.

2-The temperature distribution of the comet Ison is then governed by two mathematical equations according to the position of the comet of the nucleus. It found that the temperature distribution is obey smooth positive exponential function starting from the beginning of the tail up to the center of the nucleus while it is sharply negative exponational function starting from the center of the nucleus to the end of the comet.

3- The flow of the temperature which represented by an arrow demonstration that the directions of the flow are towards the center of the nucleus.

Reference

[1] S.Z. Khalaf, A.A. Selman and E.E. Al-lateef, International Journal of Scientific and Engineering Research, 4, 7(July 2013)39-42.

[2] S.Z. Khalaf and A.A. Selman, "Study of Comet Interaction with Solar Wind using Two-dimensional Implicit Method," Proceedings of The 3rd Conference of Science College, University of Baghdad, March 2009, pp. 695-706.

[3] M. L.Staples, J. M. Bieman, Adv. Comput., 49 (1999) 95-141.

[4] H.Wainer, P. F. Velleman, , Ann. Rev. Psychol., 52 (2001) 305-355.

[5] A. R.Teyseyre, M. R.Campo, IEEE Trans. Visual. Comput. Graph., 15 (2009) 87-105.

[6] I.Antcheva, M.Ballinijn, B.Bellenot. "ROOT- A C++ framework for petabyte data storage, statistical analysis and visualization"(2009) Computer Physics Communications, Volume 180, Issue 12, pp. 2499-2512.

[7] B. A. Berg, Phys. Procedia 15 (2011) 17.

[8] Abram Krislock1, Nathan Krislock, May 21, 2014"Resolving Histogram Binning Dilemmas with Binless and Binfull Algorithms", Astronomy & Astrophysics,

from arXiv:1405.0468v1 [astro-ph.EP] 20 May 2014.
[9] Salman Z. Khalaf, Ahmed A. Selman
Um Salma Science Journal, 5 (2008) 581-592.
[10] M. Ag´undez, N. Biver, P. Santos-Sanz, D. Bockel´ee-Morvan, and R. Moreno, (2014), "Molecular observations of comets C/2012 S1 (ISON) and C/2013 R1 (Lovejoy): HNC/HCN ratios and upper limits to PH3", Astronomy & Astrophysics, from arXiv:1403.0463v2 [astro-ph.EP] 8 Mar 2014
[11] Imtiaz Ahmad, Sidra Khalid and Ehsan E. Khawaja. " Filament temperature of low power in candescent lamps: Stefan-Boltzmann law", School of Science and Technology , University of Management and Technology, C-II Johar Town, Lahore 54770, Pakistan, 2009.
[12] David Jacobs,"Image Gradients" Class Notes for CMSC 426, Fall 2005.