VENUS TRANSIT 2004
and IMAGE PROCESSING

Stanislava Šimberová
mailto:ssimbero@asu.cas.cz

May 7, 2004

OUTLINE

- **Goals of Image Processing in the VT-2004 Project**

OUTLINE

- Goals of Image Processing in the VT-2004 Project

- Skeleton of the Pipeline

OUTLINE

- Goals of Image Processing in the VT-2004 Project
- Skeleton of the Pipeline
- Image Enhancement

OUTLINE

- Goals of Image Processing in the VT-2004 Project
- Skeleton of the Pipeline
- Image Enhancement
- Image Restoration and Analysis

OUTLINE

- Goals of Image Processing in the VT-2004 Project
- Skeleton of the Pipeline
- Image Enhancement
- Image Restoration and Analysis
- Aditional Mathematical Operation and Distance Computation

DIGITAL IMAGE PROCESSING

is used for three fundamental purposes:

-improving the visual appearance of images to a human viewer

DIGITAL IMAGE PROCESSING

is used for three fundamental purposes:

-improving the visual appearance of images to a human viewer

-preparing images for further analysis

DIGITAL IMAGE PROCESSING

is used for three fundamental purposes:

-improving the visual appearance of images to a human viewer

-preparing images for further analysis

-investigating hidden information in the image

In the image processing chain:

In the image processing chain:

- **menu of the methods**

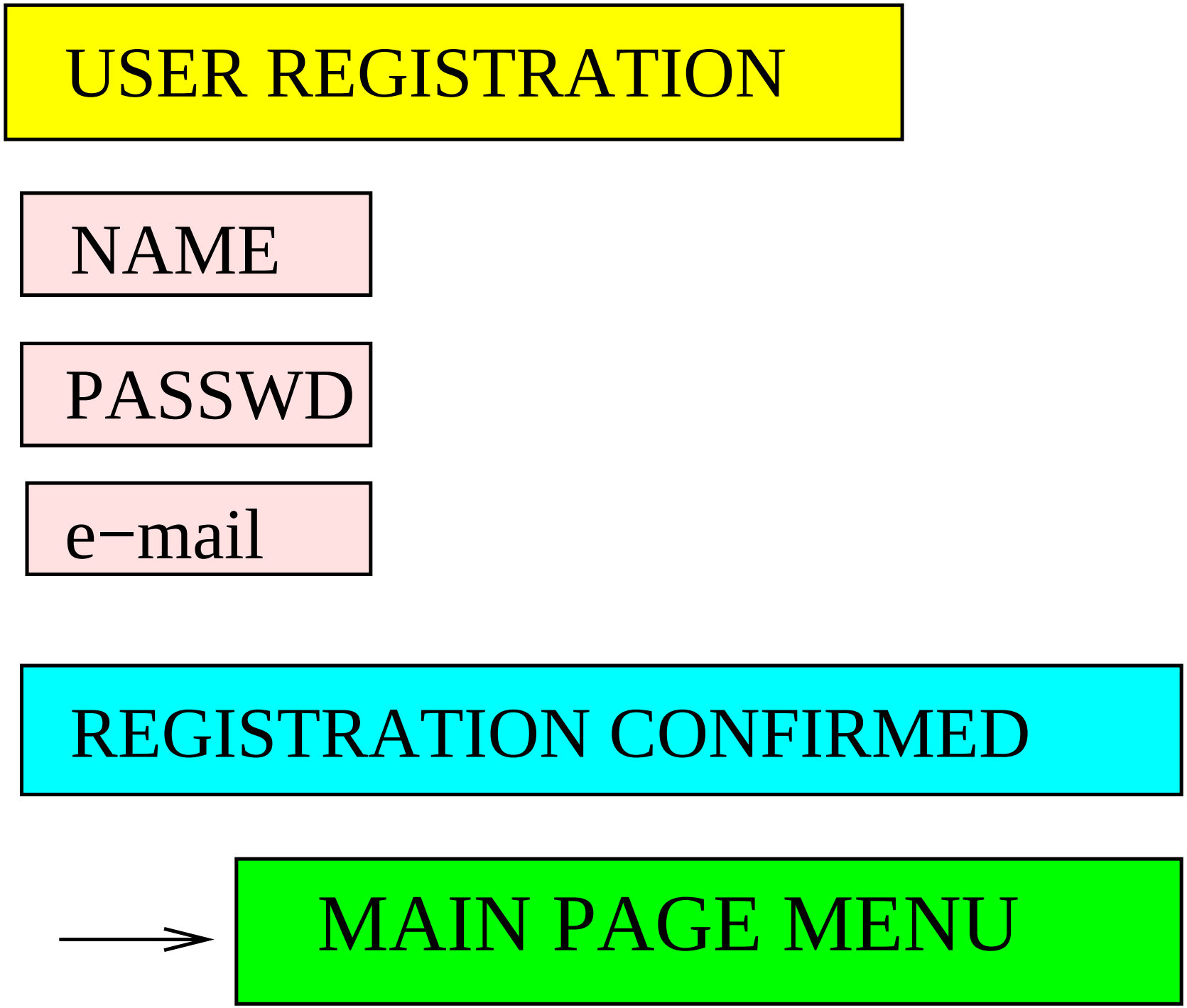
In the image processing chain:

- **menu of the methods**

- **INFO + EXAMPLES**

In the image processing chain:

- menu of the methods
- INFO + EXAMPLES
- application to the real image fits, gif, jpeg


USER REGISTRATION
NAME
PASSWD
e−mail
REGISTRATION CONFIRMED
MAIN PAGE MENU

Professional observatories

ONDREJOV //asu.cas.cz/~sunwatch

PARIS link to http:// ...

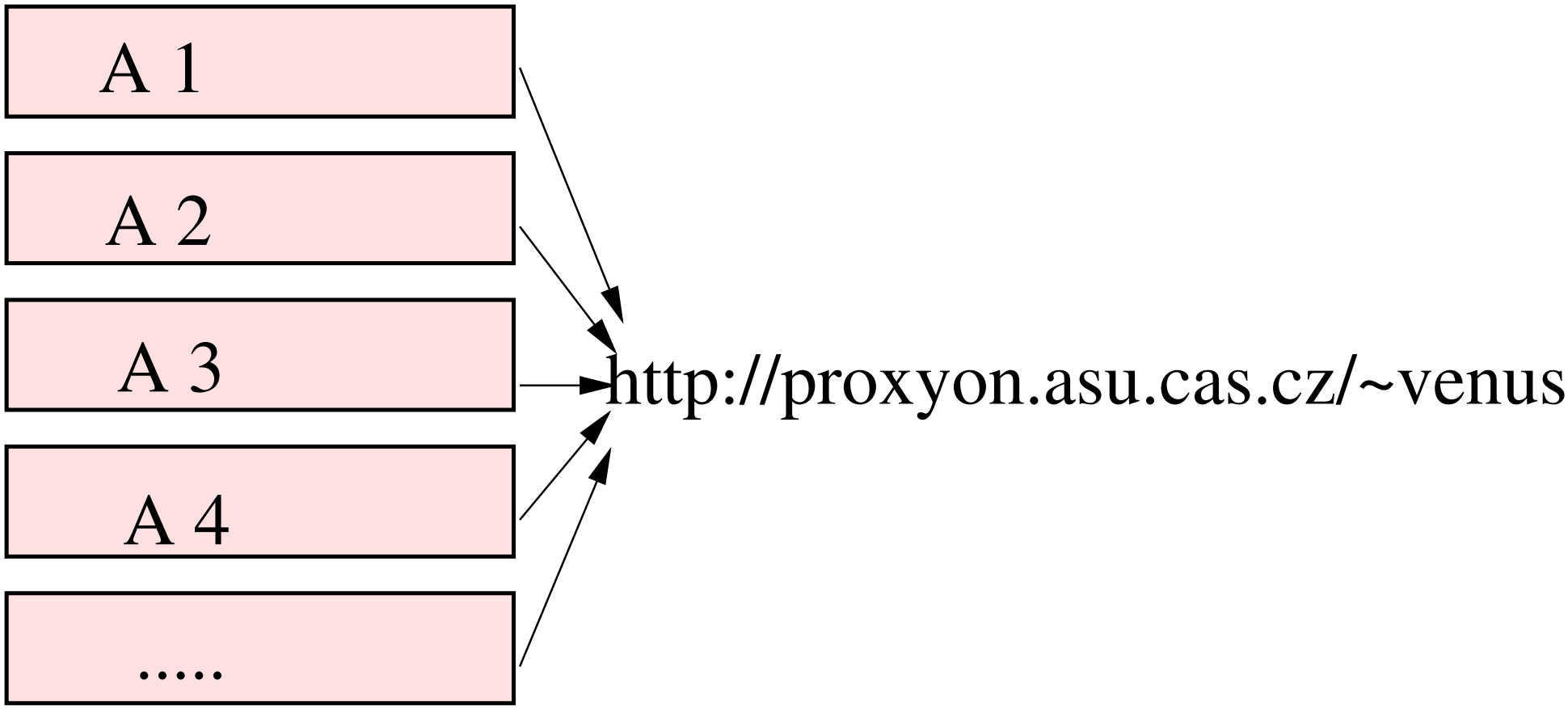
ESO link to http:// ...

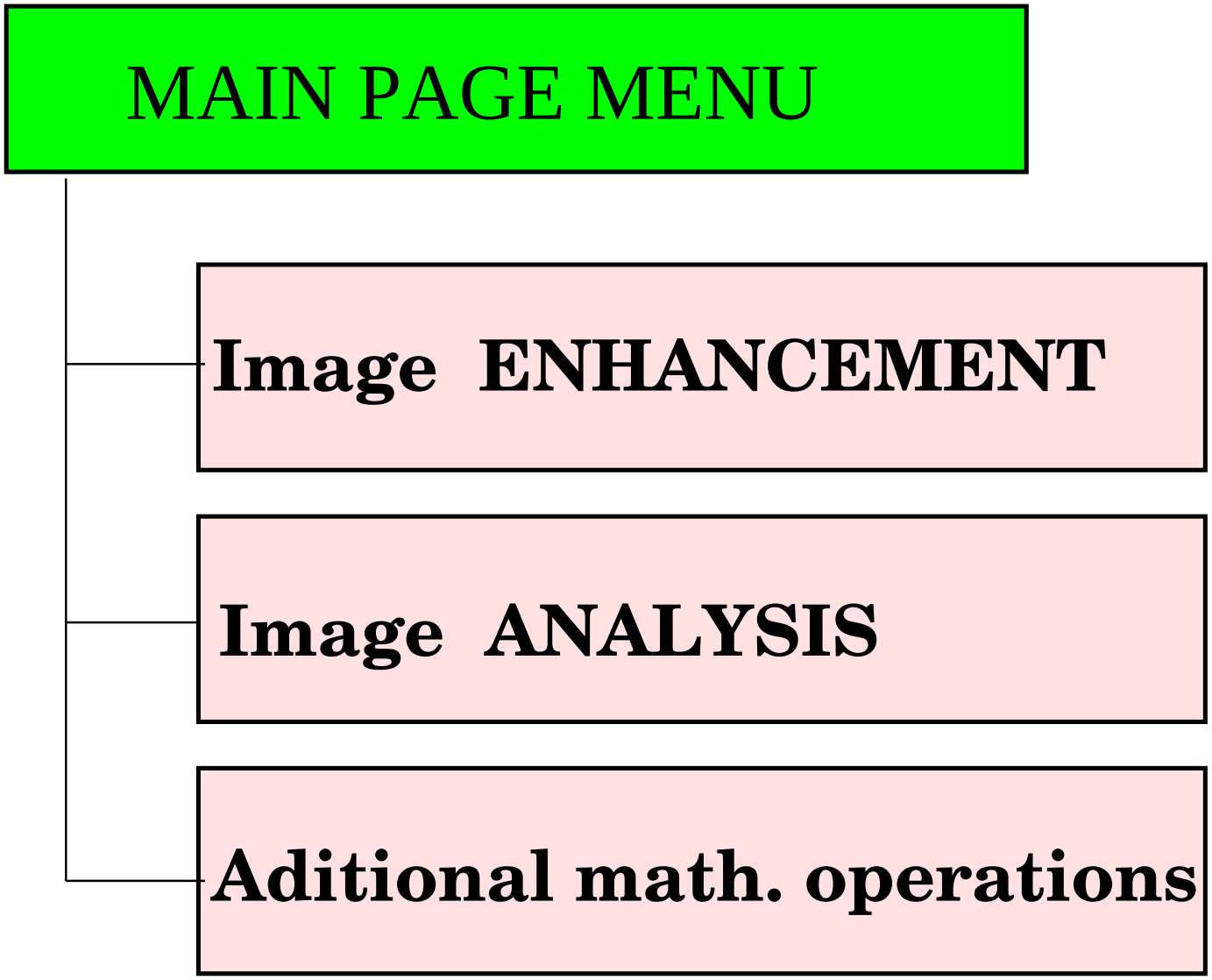
TENERIFE link to http:// ...

...etc.

MAIN PAGE MENU

PLACES of observation – amateur observations




MAIN PAGE MENU
Image ENHANCEMENT
Image ANALYSIS
Aditional math. operations

MENU – processing methods

IMAGE ENHANCEMENT

- CONTRAST manipulation — INFO — Example
- HISTOGRAM modification — INFO — Example
- NOISE cleaning — INFO — Example
- EDGE crispening — INFO — Example

MENU – processing methods

IMAGE ANALYSIS

EDGE detection

PREWITT	INFO	Example
SOBEL	INFO	Example
ISOTROPIC	INFO	Example
LAPLACE 1	INFO	Example
LAPLACE 2	INFO	Example
CONE	INFO	Example

MENU – processing methods

Aditional math. operation

Subtraction	INFO	Example
Addition	INFO	Example
Multipl./divis.	INFO	Example
Statistics	INFO	Example
Histogram	INFO	Example

DISTANCE computation

DISTANCE COMPUTATION

ONDREJOV observatory

FULL DISC OBSERVATION in $H\alpha$ and white light

DISTANCE
Venus (barycenter)
SUN (limb or center)

OWN OBSERVATION

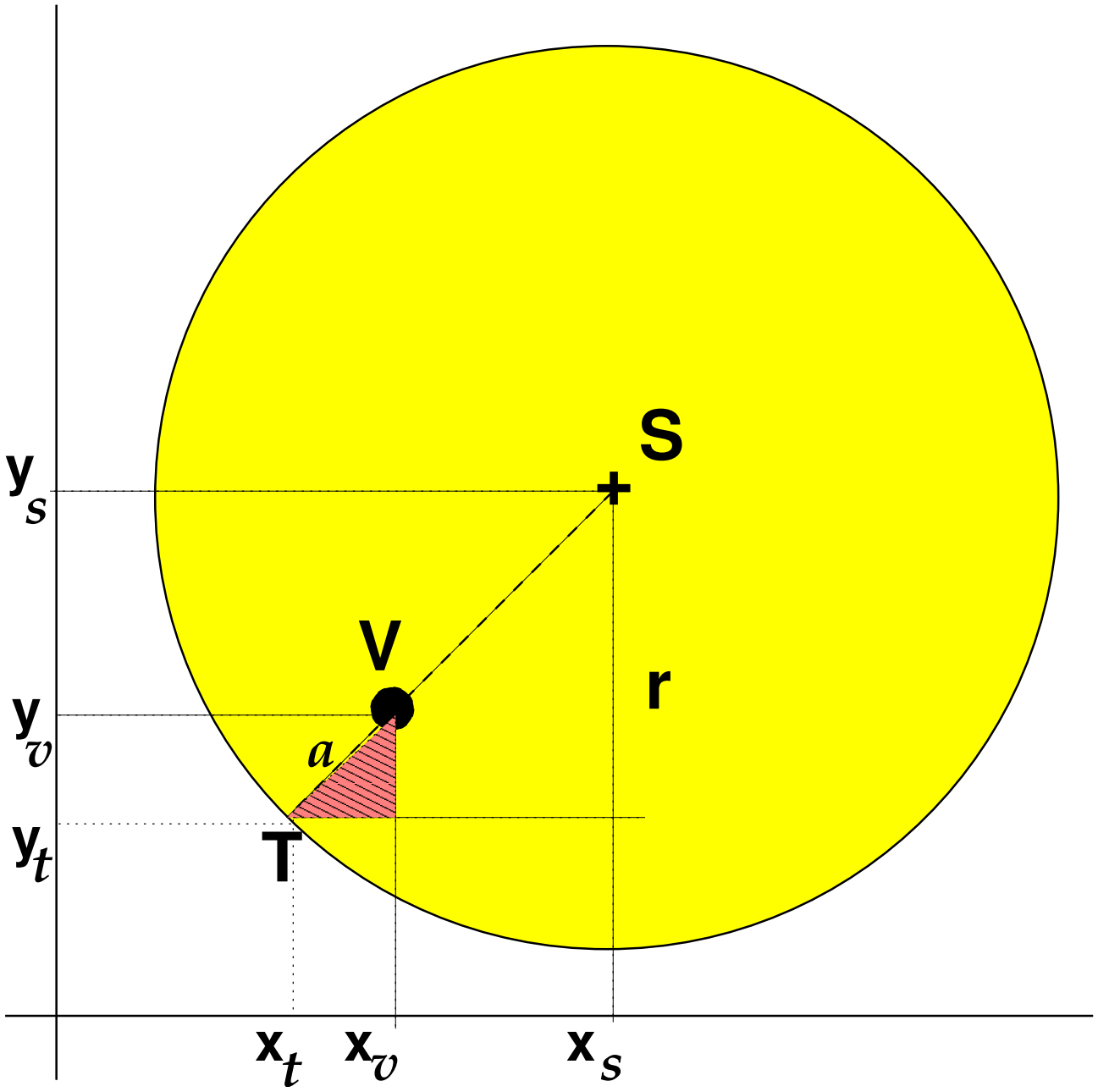
Data acquisition page

Demands for observ.

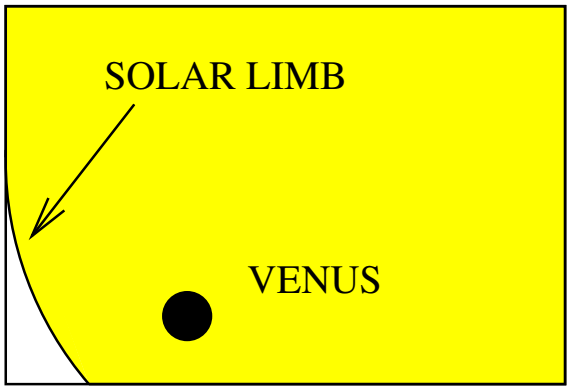
Bad examples

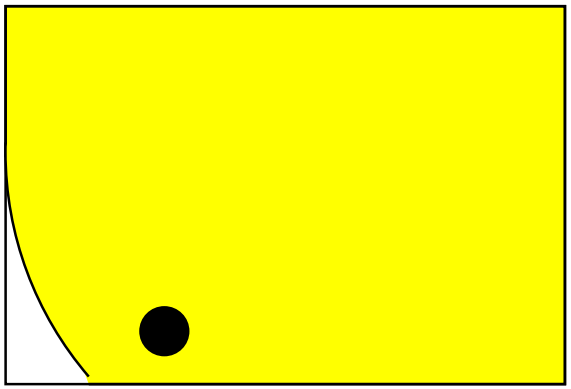
insert image + text.file

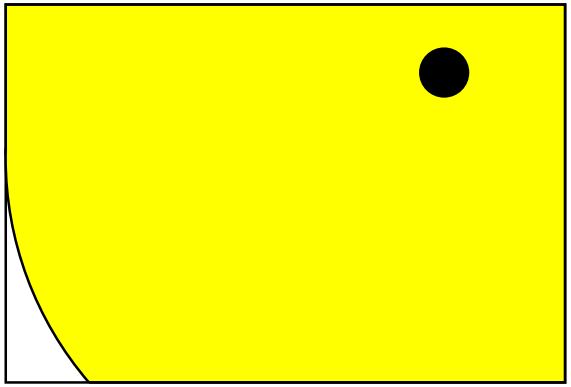
$$a = r\,(x_v - x_t) / (x_s - x_t) = r\,(y_v - y_t) / (y_s - y_t)$$

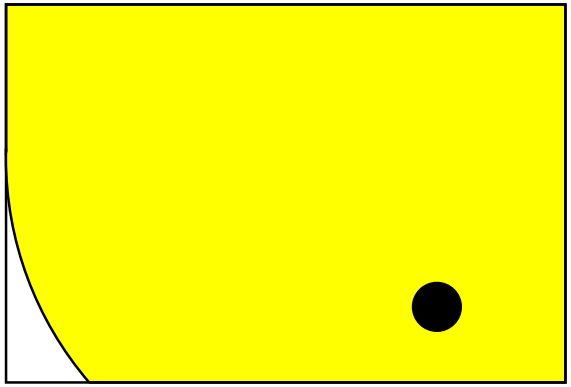


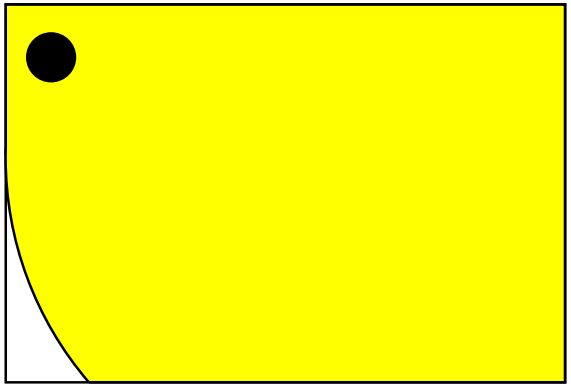
EXAMPLES OF THE NON–ACCEPTED IMAGES











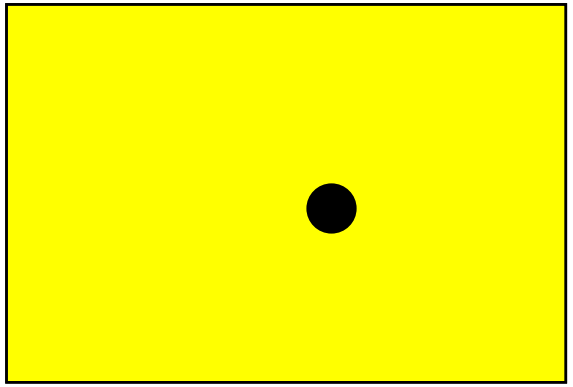


IMAGE ENHANCEMENT and ANALYSIS

- consisting of various techniques that seek to improve the visual appearance of an image

IMAGE ENHANCEMENT and ANALYSIS

- consisting of various techniques that seek to improve the visual appearance of an image

- preprocessing methods to prepare an image for analysis

IMAGE ENHANCEMENT and ANALYSIS

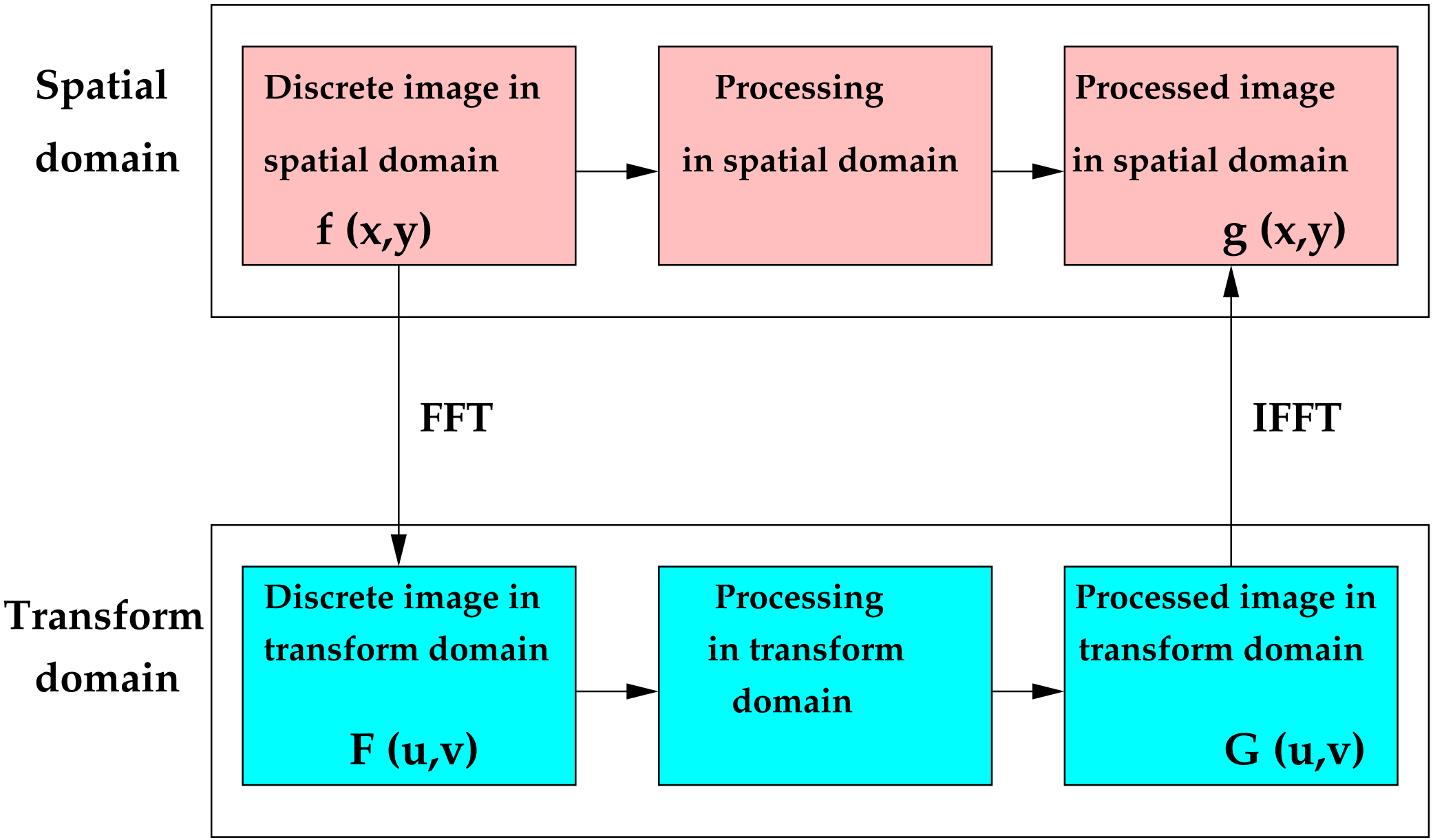
- consisting of various techniques that seek to improve the visual appearance of an image

- preprocessing methods to prepare an image for analysis

- the basis of linear filtering is convolution teorem

$$g(x, y) = f(x, y) * h(x, y)$$

Basic Scheme of Digital Image Processing



$$f(x, y) * h(x, y) \Leftrightarrow F(u, v) \cdot H(u, v)$$

$$f(x, y) \cdot h(x, y) \Leftrightarrow F(u, v) * H(u, v)$$

The discrete convolution equation

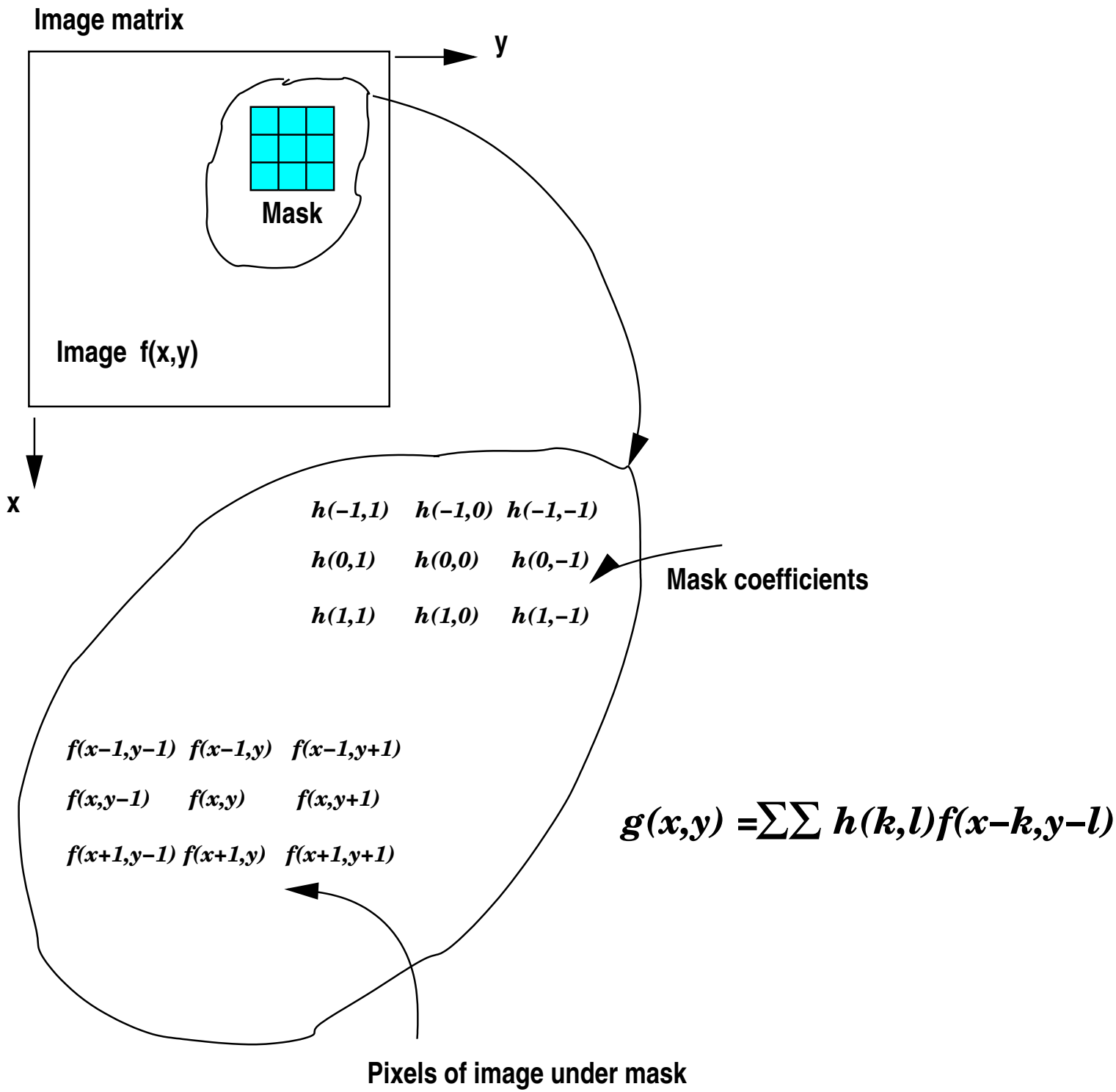
$$G(j,k) = \sum_m \sum_n F(m,n)\ H(m-j-C, n-k+C)$$

where G (j,k) – filtered output image

F (j,k) – input image

H (j,k)– impulse response array L x L size

C = (L + 1) / 2



$$g(x,y) = \sum\sum h(k,l) f(x-k,y-l)$$

CONTRAST manipulation

special transfer functions

⟶ different range of density

f 1, f 2, ..., f 8

HISTOGRAM modification

EQUALIZATION

– based on cumulative histogram

⟶ to enhance contrast by the uniform distribution of density, but the details are preserved

NOISE cleaning

additive noise –> discrete isolated pixel variations

⟶ cleaning algorithms are based on spatial operations performed on local neighborhoods of input pixel

⟶ LOW – PASS FORM of the impulse response

N 1, N 2, ..., N 9
Smoothing, Median, Gauss, Min, Max, ...

EDGE crispening

an image with accentuated edges is more pleasing than exact photometric reproduction

⟶ convolution with HIGH –PASS FORM of the impulse response

E 1, E 2, ... , E 5

Masks of the high–pass filters, Sharp, Point, Tent, ...

IMAGE ANALYSIS

data exctraction, image description, segmentation, scene analysis

EDGE detection

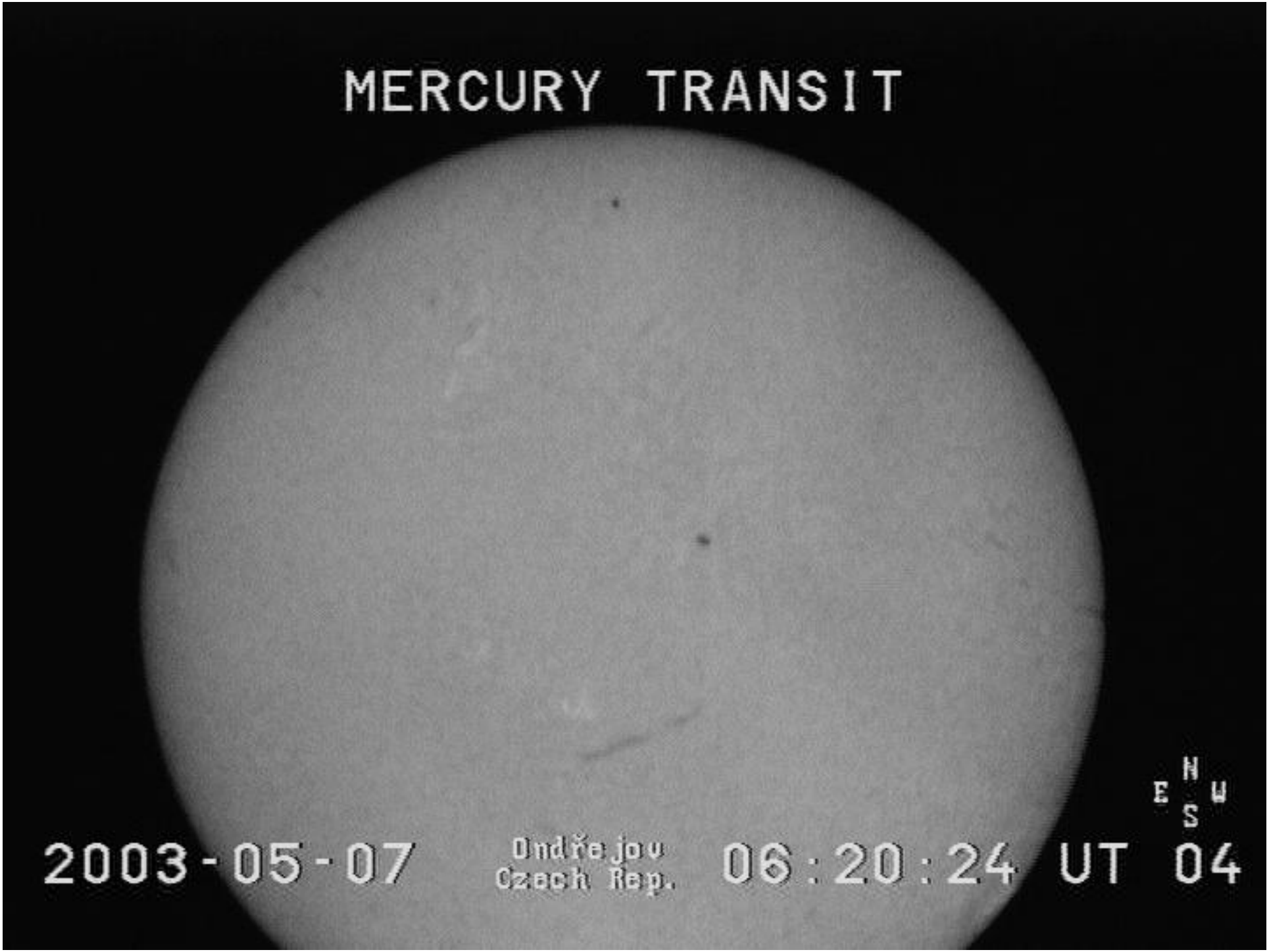
→ **Edges characterize object boundaries.**

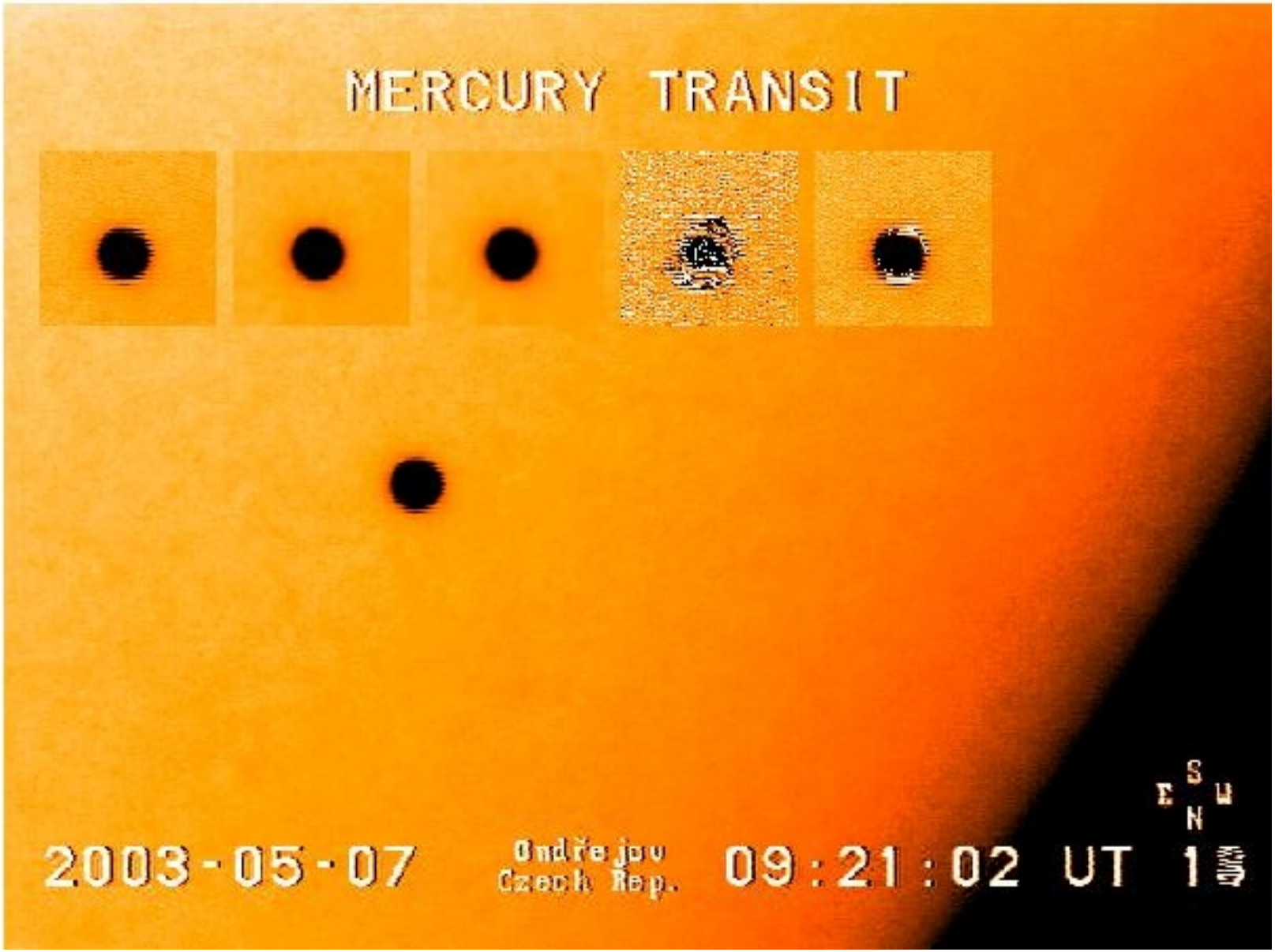
→ **Edge, line and spot locations are specified by dark pixels against a light background**

Methods based on

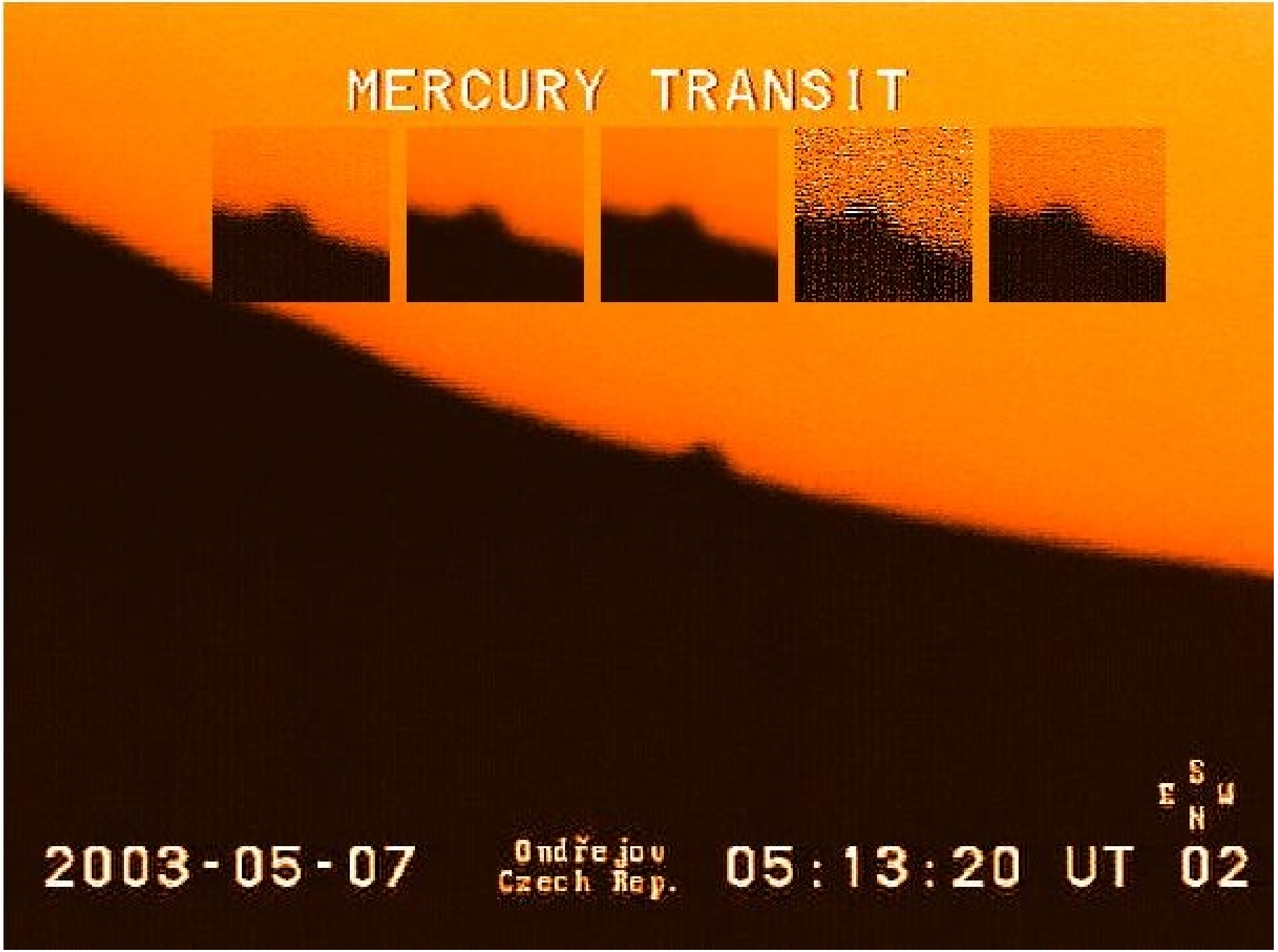
- **the first order derivative of an image function**
  ROBERTS, PREWITT, SOBEL, FREI–CHEN, ...
  involve generation of gradients in two orthogonal directions. **D 1, D 2, D 3**

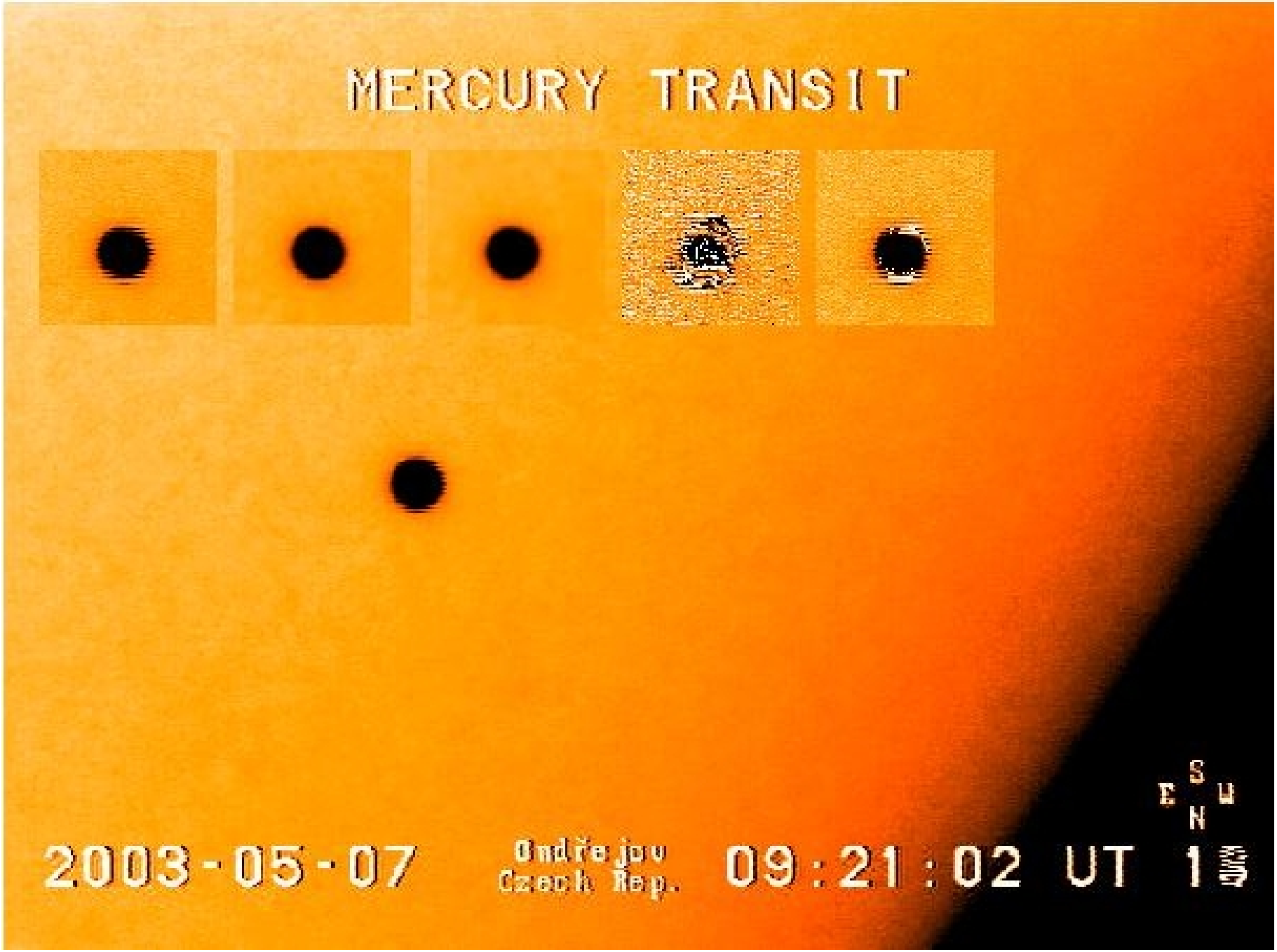
- **the second order derivative**
  LAPLACE (4, 8 neighbor; Laplacian of Gaussian)
  An edge is marked if a significant spatial change occurs in the 2nd derivative. **D 4. D 5. D 6**

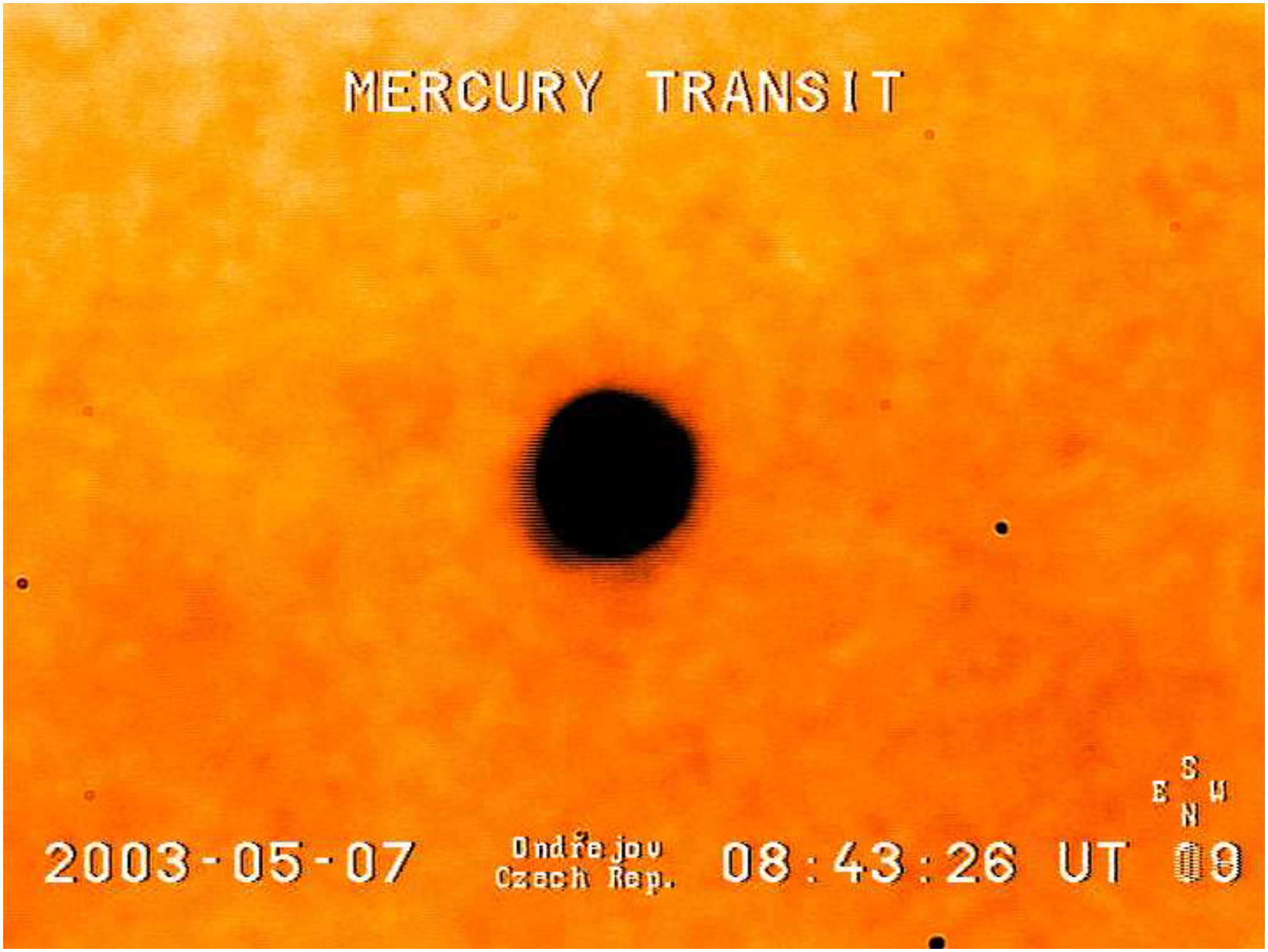

MERCURY TRANSIT
N
E
W
S
2003-05-07
Ondřejov
Czech Rep.
06:20:24 UT
04

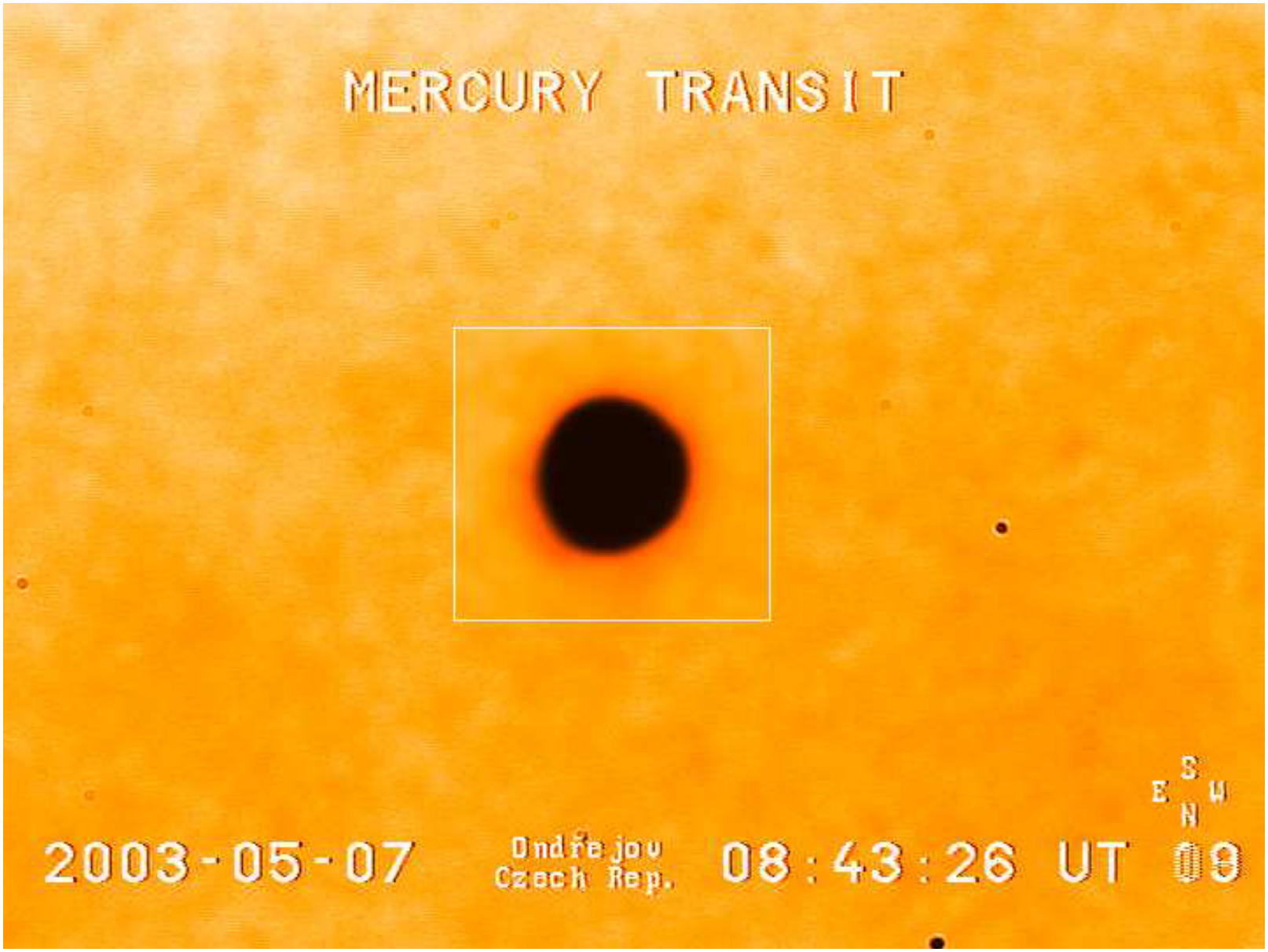

MERCURY TRANSIT
E
S
N
W
2003-05-07
Ondřejov
Czech Rep.
09:21:02 UT

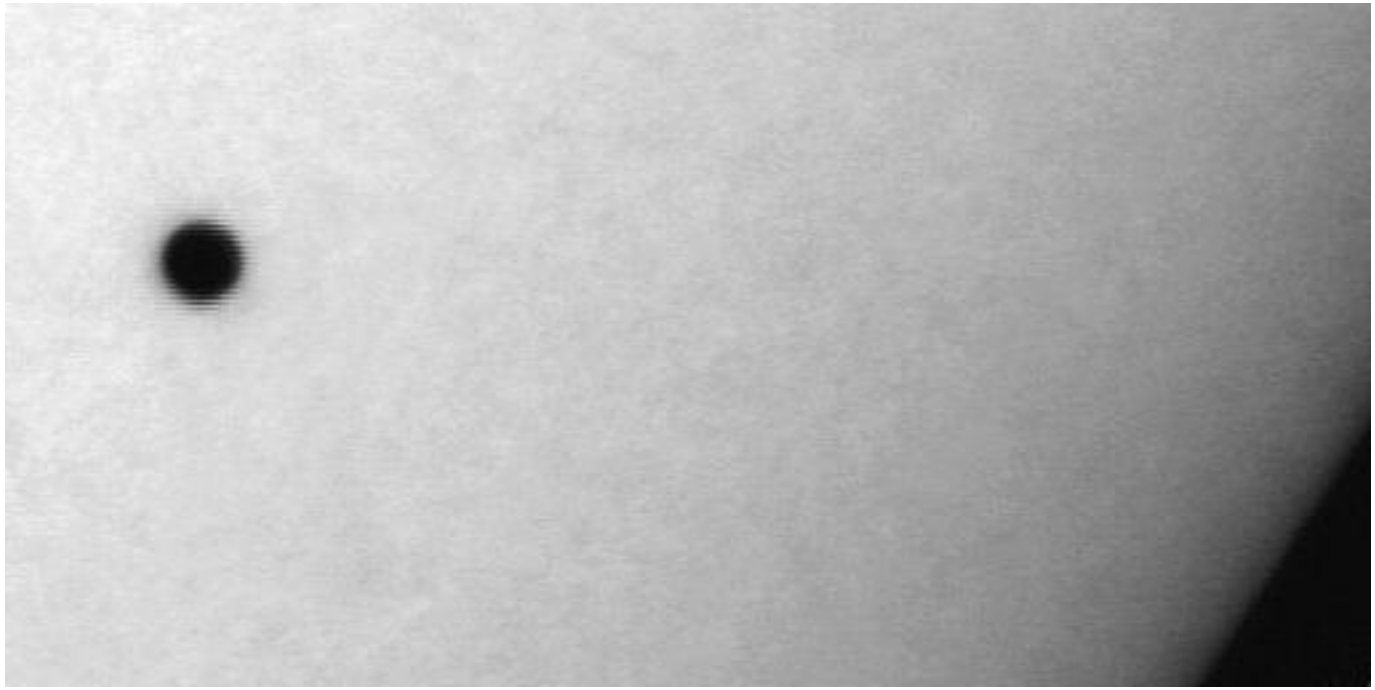

MERCURY TRANSIT
S
E
W
N
2003-05-07
Ondřejov
Czech Rep.
05:16:10 UT
20


MERCURY TRANSIT
E
S
N
W
2003-05-07
Ondřejov
Czech Rep.
05:13:20 UT
02

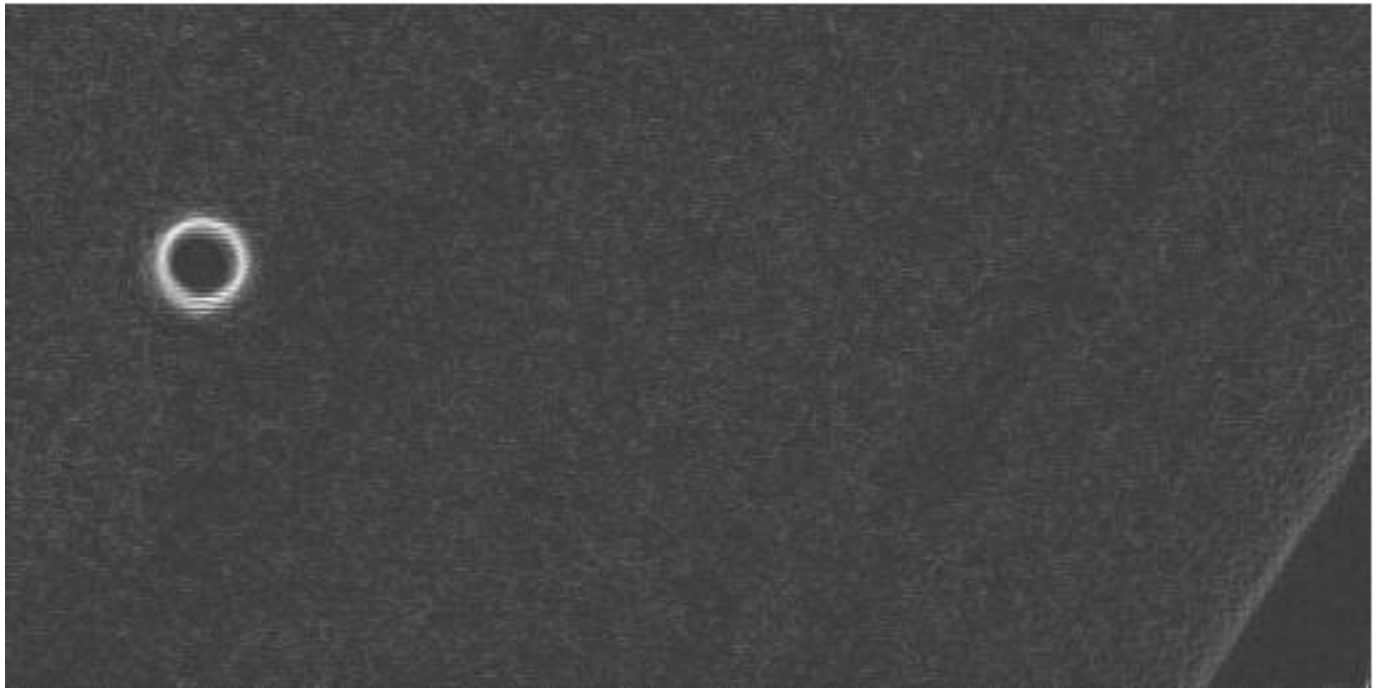

MERCURY TRANSIT
2003-05-07
Ondřejov
Czech Rep.
09:21:02 UT
E
S
N


MERCURY TRANSIT
2003-05-07
Ondřejov
Czech Rep.
08:43:26 UT
E
S
N
W

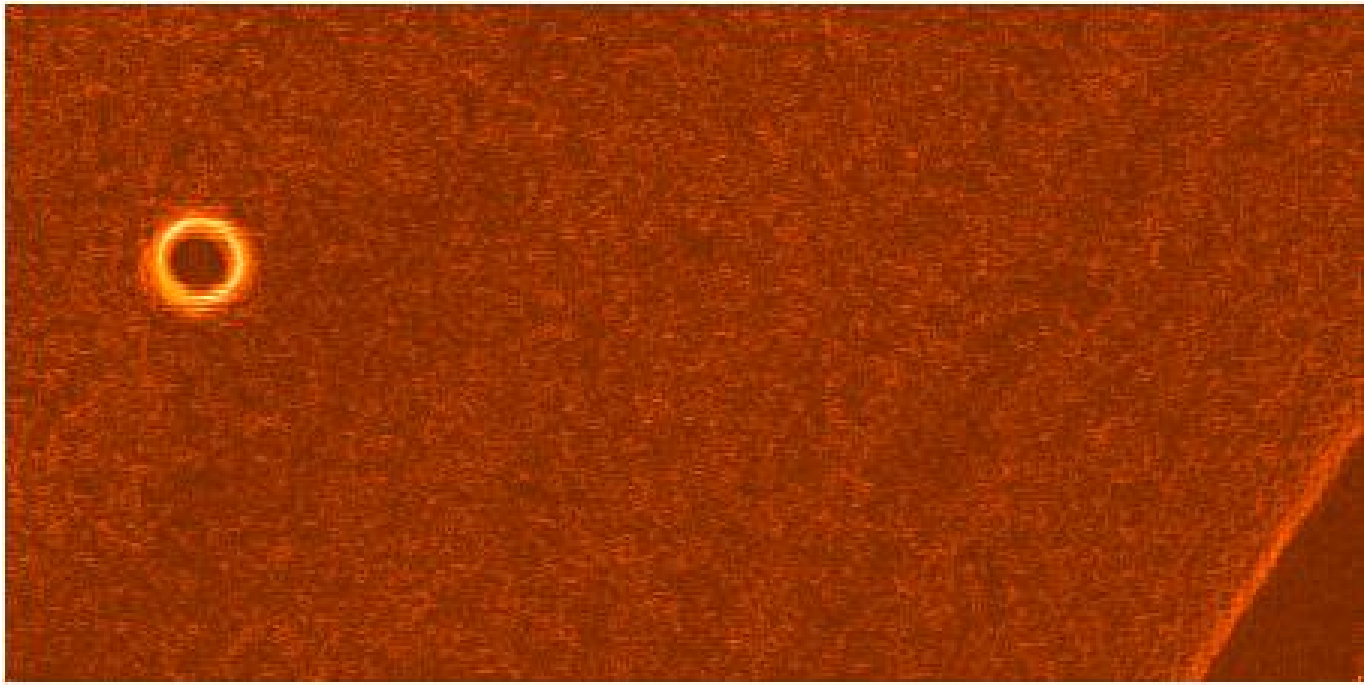

MERCURY TRANSIT
E
S
N
W
2003-05-07
Ondřejov
Czech Rep.
08:43:26 UT

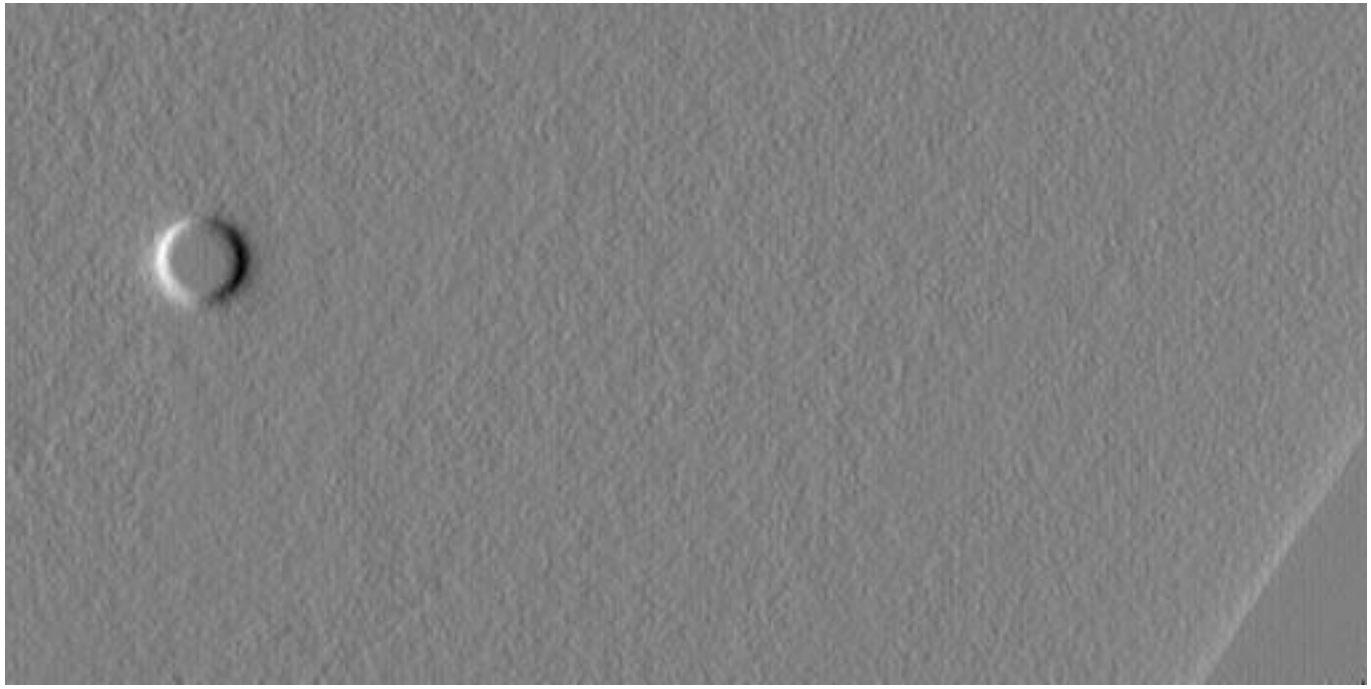


Prewitt operator

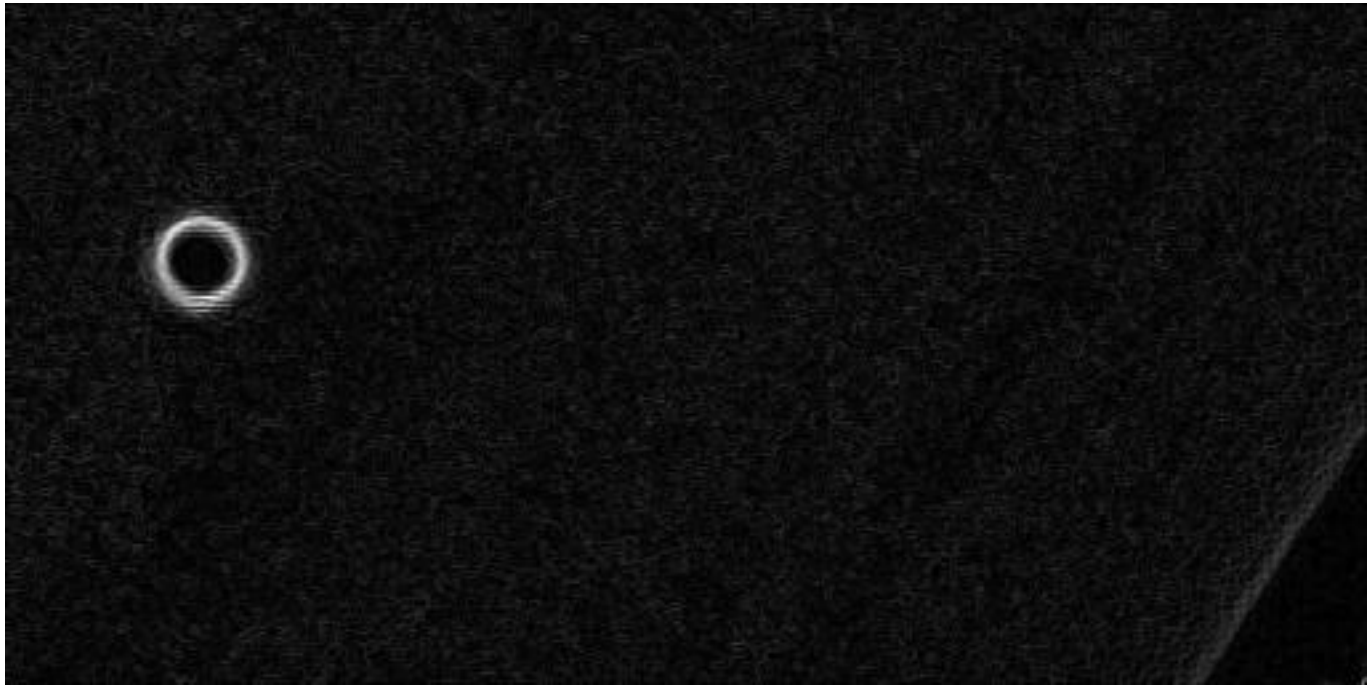


Prewitt operator

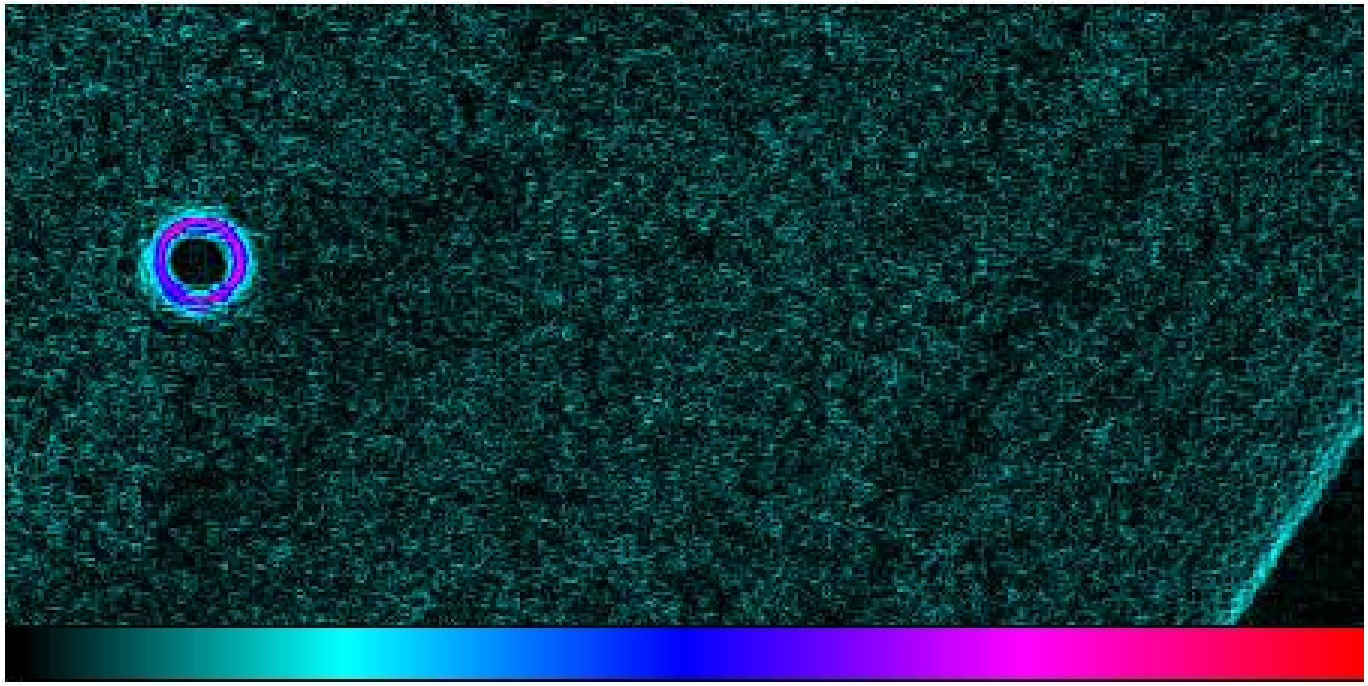


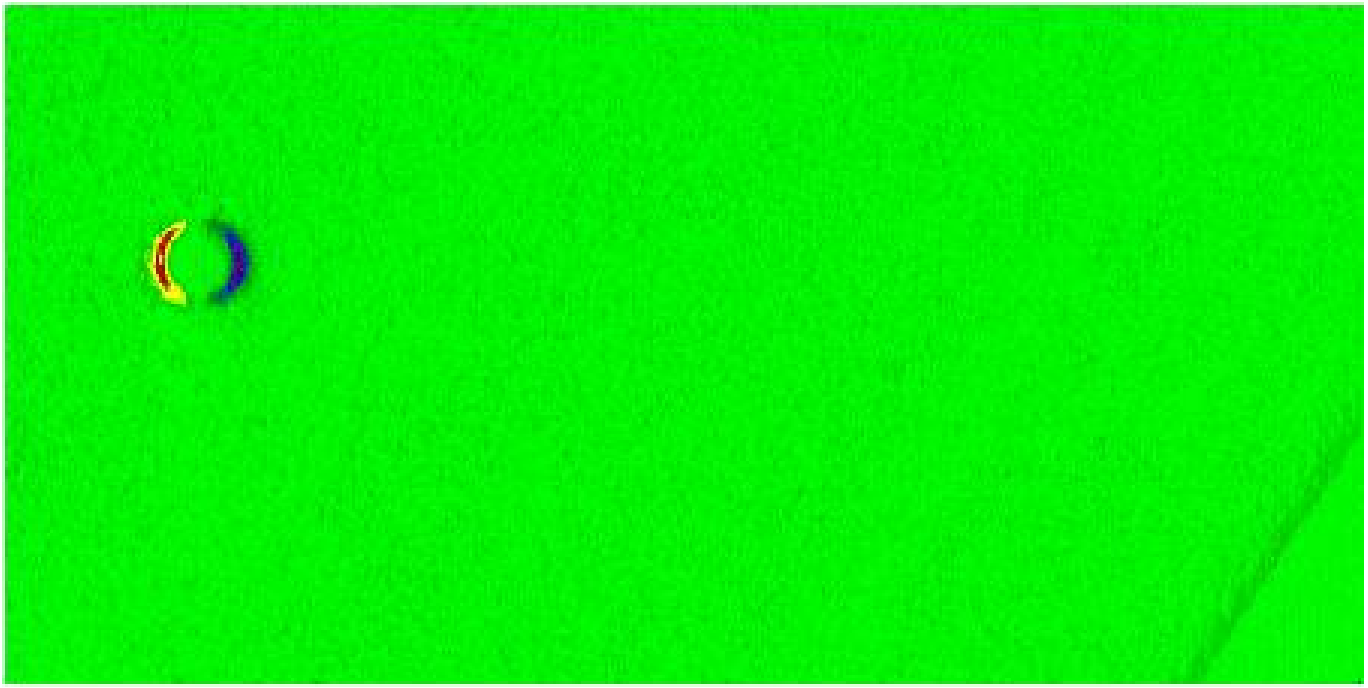


Sobel operators horizontal, vertical

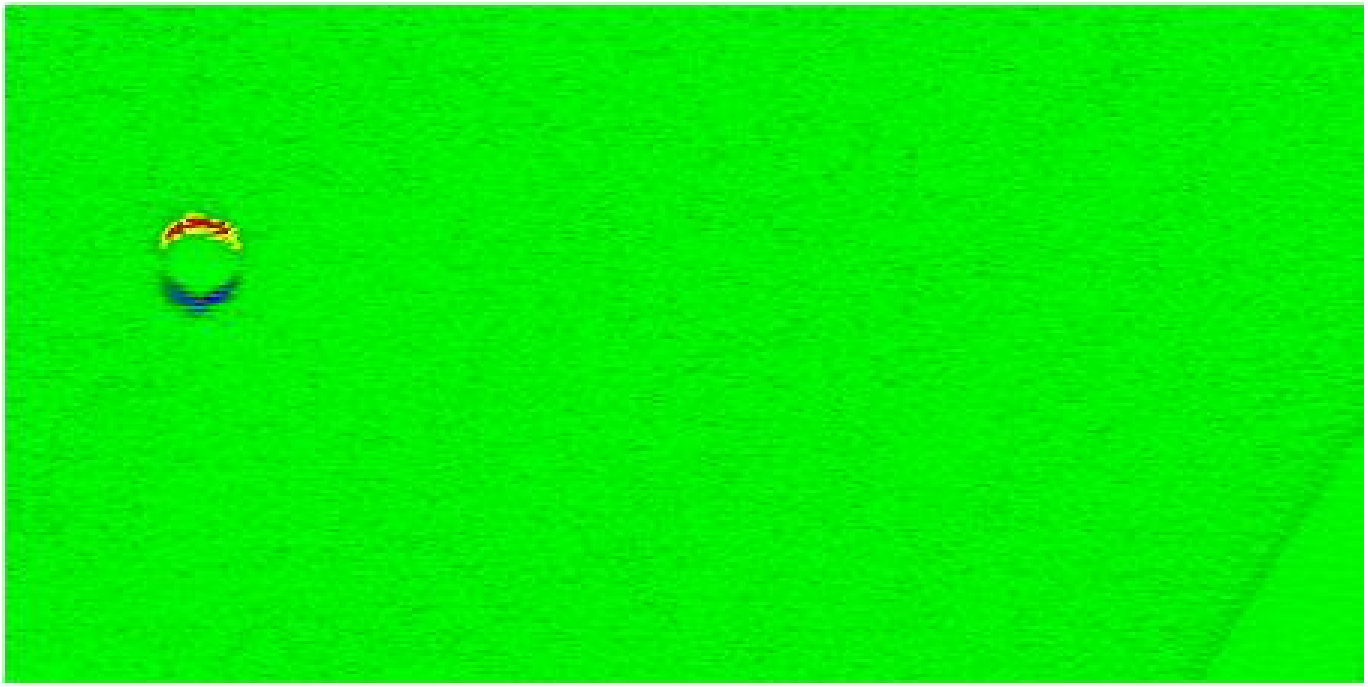


Result of Sobel operators

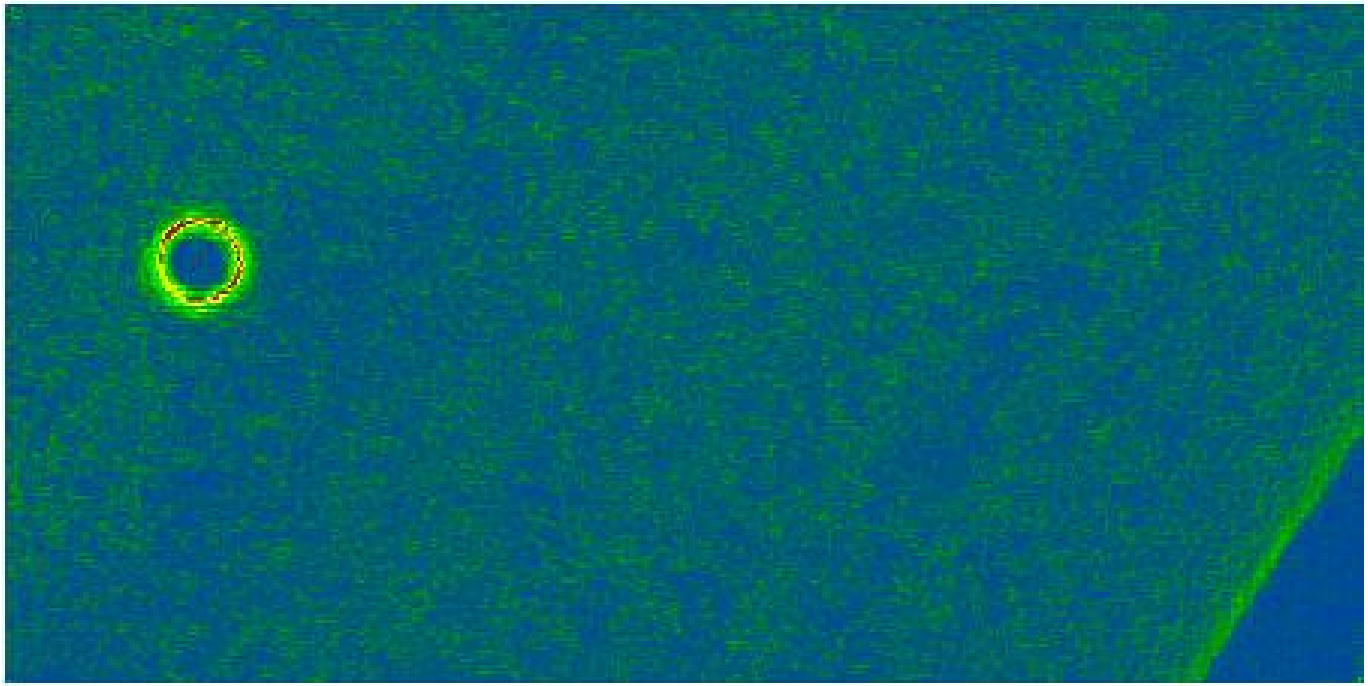


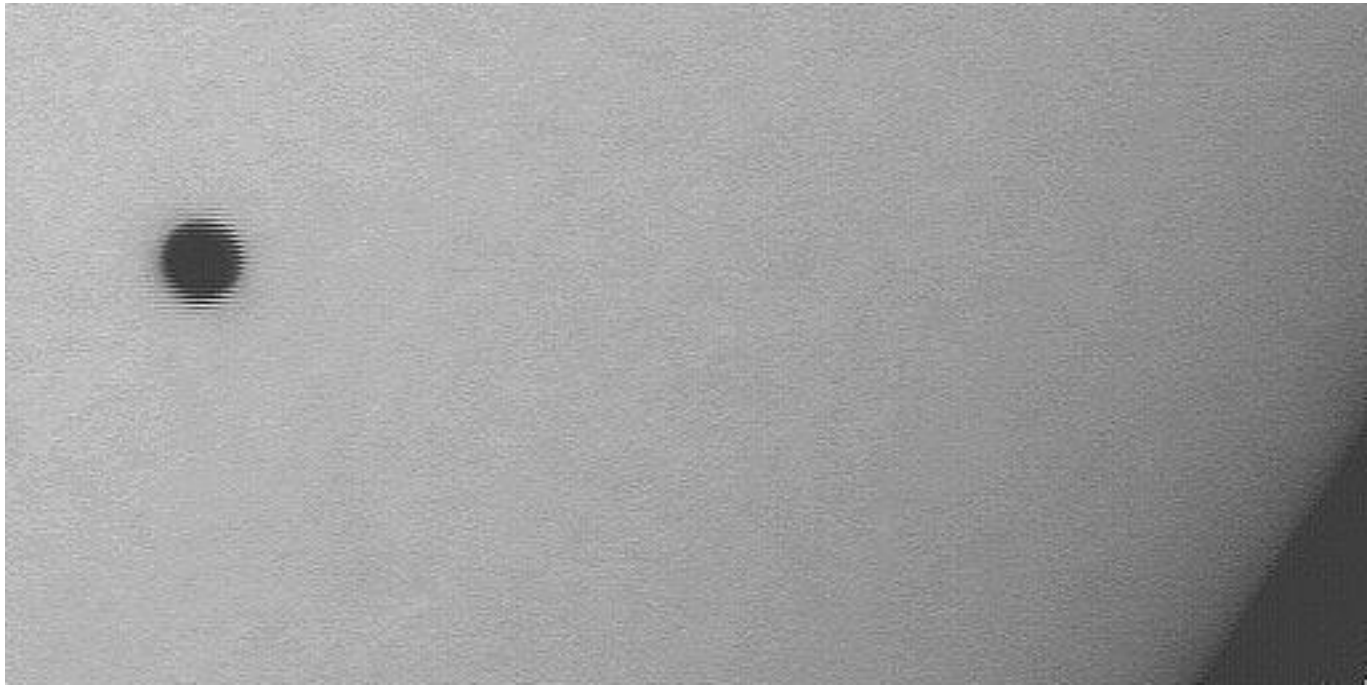


Prewitt operators horizontal, vertical

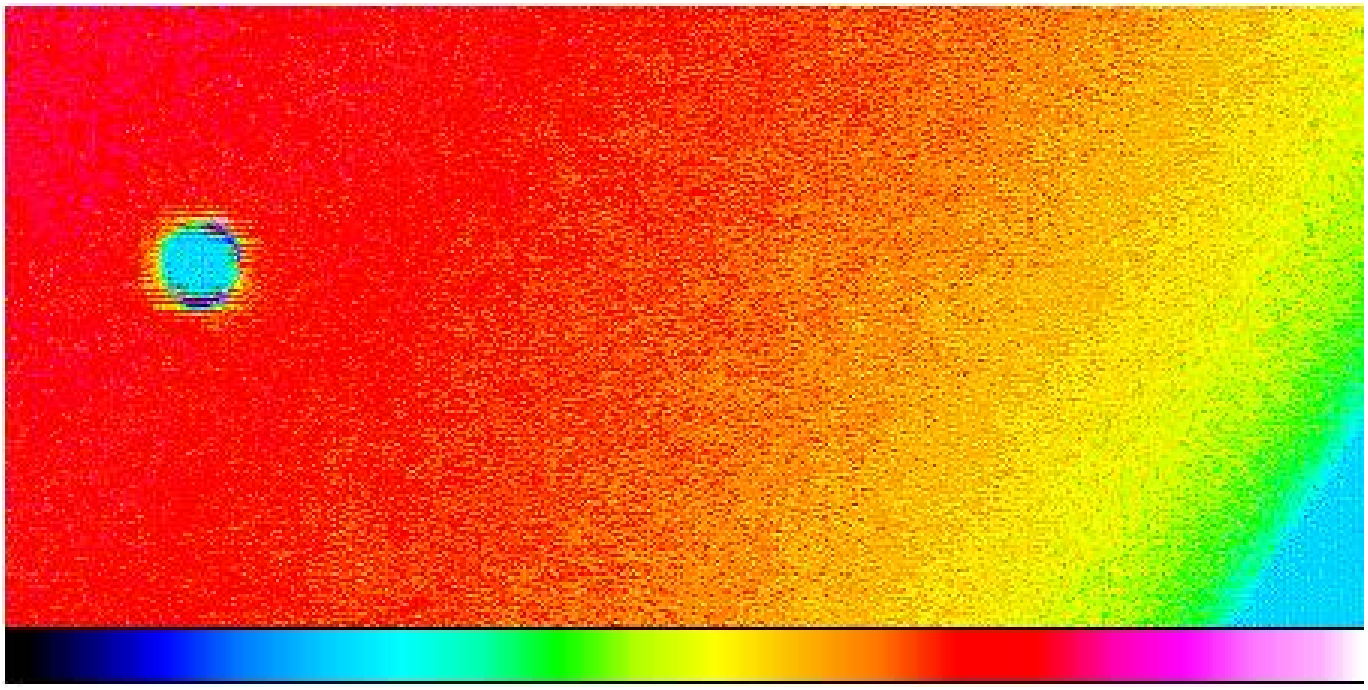


Result of Prewitt operators





Result of Laplace1 operator



IN ASTRONOMY YOUR IMAGE IS EVERYTHING.

ONE PICTURE IS WORTH MORE THAN TEN THOUSAND WORDS.

Anonymous