Observational Mishaps - a Database

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Abstract

We present a World-Wide-Web-accessible database of astronomical images which suffer from a variety of observational problems, ranging from common occurences, such as dust grains on filters and/or the dewar window, to more exotic phenomena, such as loss of primary mirror support due to the deflation of the support airbags. Apart from its educational usefulness, the purpose of this database is to assist astronomers in diagnosing and treating errant images *at the telescope*, thus saving valuable telescope time. Every observational mishap contained in this on-line catalog is presented in the form of a GIF image, a brief explanation of the problem, and, when possible, a suggestion for improving the image quality.

Introduction

It is not uncommon for an astronomical image obtained after a lengthy integration to reveal that all is not well. As a consequence, telescope time is sacrificed identifying the problem. In an effort to shorten this investigation period, we have created a catalog of astronomical images bearing signatures of a range of mishaps encountered during observing runs. Included with each image is an explanation of the cause of the problem as well as a suggested solution. Since a large number of observatories today are connected to the Internet, the World Wide Web (WWW) was chosen as the ideal medium for presenting this collection of images.

Initially, the purpose of such a collection was to assist new graduate student observers at Michigan-Dartmouth-MIT (MDM) Observatory who frequently observe without the benefit of a more experienced observer. The aim was to provide these students with a means of quickly pinpointing the underlying problem affecting the image quality. This idea grew into a WWW accessible database complete with explanations of the "mishaps" responsible for the deterioration of the images, as well as suggested solutions.

The Format of the Database

Every WWW page in this catalog contains an inverted colormap GIF image of the mishap, a table listing relevant information about the image (telescope, date, instrument, filter, exposure time), a brief description of the problem, and, if available, a suggestion of how to fix it. In a few cases, the cause of the problem could not be determined. These were dubbed "Unsolved Mysteries", and no explanation of the problem or suggestion for a fix are given.

Since it is possible for one problem to manifest itself in a variety of ways, multiple images of the same mishap are presented where appropriate, cross referenced with the help of hypertext links. For example, condensation on the dewar window can appear as a filamentary structure or as a bright extended feature with cusps, depending on the locations of light sources in the field of view.

For the more common problems of astigmatism, coma, bad guiding/focusing, and poor seeing, we have provided supporting plots/images where applicable via links on the relevant pages. Examples include radial profile plots across a stellar image or multiple images of the same field taken in different seeing conditions.

In this presentation, we show several examples of typical pages in the database, along with the explanations of the problems and suggestions for solutions.

The Structure of the Database

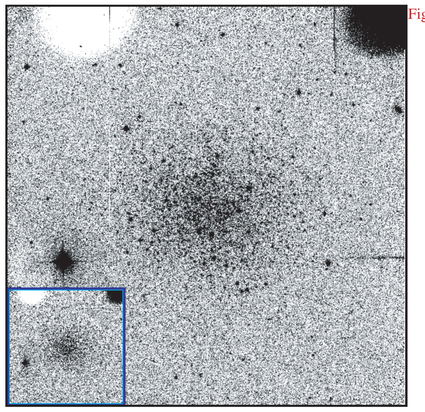
Much consideration was given to effectively structuring the image catalog. Rather than sorting the images by cause, which is probably unknown to the astronomer accessing the database, we have grouped them by symptom. We provide the following two options for searching the database:

1. The user may browse the complete list of compiled images. This list features links to the various mishap pages as well as a brief description (1 - 2 lines) of the symptoms in the corresponding image.

2. The other option is to first broadly classify the image based on its symptoms and then choose the appropriate web page from a smaller list. This option will likely be more practical with an increasing number of images in the database. Apart from the frequently occuring problems of bad seeing/focusing/guiding, fringing, dust rings, and reflections, the current revision of the database lists the following as the top categories:
   - Unusual Appearance of Objects in the Image: familiar objects in the image, such as galaxies, stars, etc, have an unexpected appearance (e.g., guider jumps, deflated airbags, etc).
   - CCD and Electronics Features: features seem to be correlated with the CCD rows or columns, or they are otherwise suspiciously electronic in appearance (e.g., readout errors, shutter failure, etc).
   - Unexpected Objects in the Image and other External Interference: unexpected features obviously not due to the CCD or the electronics appear in the image (e.g., occulting dropout shutter, condensation on the dewar window, etc).
   - Unsolved Mysteries: as mentioned above, these are the cases for which we have so far not been able to determine the cause of the problem.

Each of the above links leads to a list of mishap pages in that category with a brief description of the corresponding image appearance.

Fig.2



Telescope	MDM 1.3m
Date	5/26/1997
Instrument	Nellie
Filter	R_Dartmouth
Exposure Time	100 s
Other	Image was automatically processed.

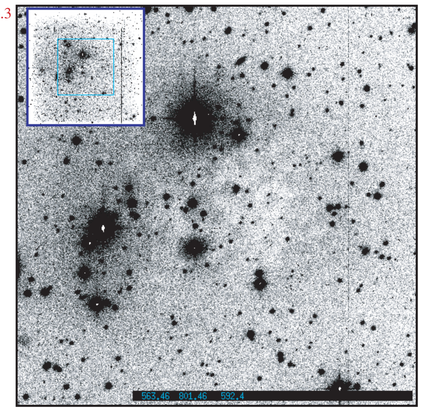
Problem:

During this run, an IRAF daemon was automatically processing every image. It turned out that a dead lady bug had fallen onto the R filter. This bug then moved when the filter wheel turned and ended up in another corner when this image was taken. I.e., the white feature in the top left corner is the lady bug on the image, the black feature in the top right corner is the one on the flatfield. In addition, there apparently was a dust grain on the I filter which moved as well after the flat was taken (visible just above the punner in the bottom left corner).

Fix:

The lady bug was removed and the R filter was cleaned.

Fig.3



Telescope	MDM 1.3m
Date	9/26/95
Instrument	Nellie
Filter	V
Exposure Time	900 sec

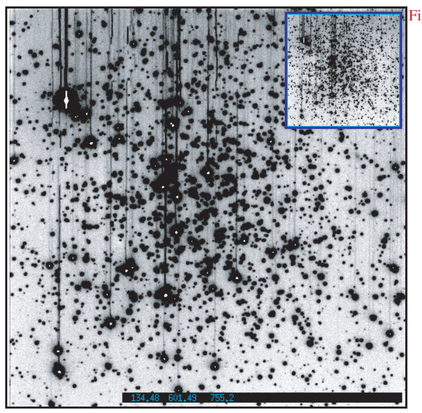
Problem:

Large dewar windows (which are especially cold) can have condensation forming at the center of the window whenever the humidity starts to rise. Different telltale symptoms can show up. One giveaway is more pronounced (darker) dust rings in the center. Other possibilities are the sudden appearance of filamentary structure or bright 'explosions' in the center of the image due to light from bright stars being dispersed by the dew.

Fix:

Fix depends on the observatory but may include dewar window heating or blowing dry nitrogen into the setup.

Fig.4



Telescope	MDM 2.4m
Date	11/19/1995
Instrument	Charlotte
Filter	V_KittPeak
Exposure Time	300 s
Other	Image not processed.

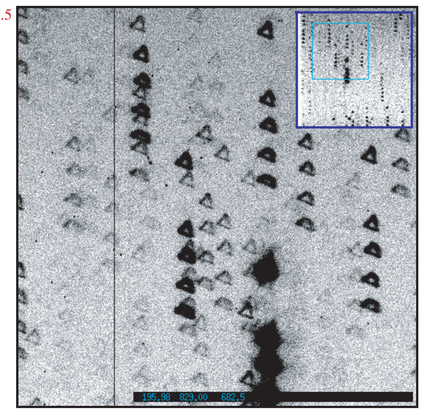
Problem:

The bright trails of the stars in this images are due to the fact that the shutter was not closed when the CCD was read out. During the readout process, light was still able to hit the CCD and produced the star trails which will therefore always point in the direction in which the CCD is read out (in this case, toward the top of the image). It is readily apparent that brighter stars produce much more of a trail than fainter ones which, if they are faint enough, do not produce any kind of noticable trail at all.

Fix:

There is no easy fix to this problem. If the shutter is actually failing, the best solution will most likely be to contact technical assistance.

Fig.5



Telescope	MDM 2.4m
Date	9/13/96
Instrument	Templeton
Filter	V_schom
Exposure Time	2.5 sec
Other	Focus Exposure

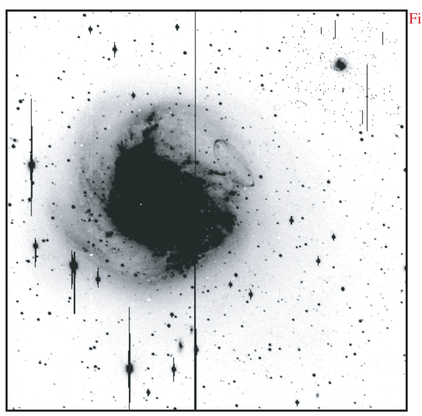
Problem:

The airbags supporting the primary mirror were deflated when this image was taken. The reason for the triangular shapes of the stars in this focus image was that the mirror is supported at 3 "hard" support points. This, of course, made it impossible to obtain a good focus.

Fix:

DO NOT MOVE THE TELESCOPE! The problem here was that the PC which ran the program responsible for the air pressure in the airbags was hung up. When it was rebooted, the airbags were re-inflated, and the problem was taken care of. A word of caution, however: **moving the telescope with deflated airbags can actually cause damage to the telescope itself.**

Fig.6



Telescope	CTIO Curtis Schmidt
Date	3/8/1999
Instrument	Tek 2k #2
Filter	Sloan r'
Exposure Time	900 s
Other	Image not processed.

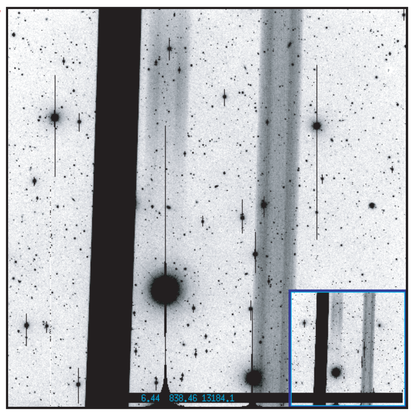
Problem:

This stellar ghost image just to the top right of M83 (the galaxy) is a feature frequently encountered during observing runs with Schmidt telescopes. It normally does not occur with other telescopes. What happens is that light from a bright star in the field reflects off the primary, then off the Schmidt corrector plate, then off the primary again, then to the secondary and detector. The "stellar ghost" always appears diagonally opposite about the center of the field of view from the offending star. Its shape may vary depending on the Schmidt and filter used, but the feature is common to Schmidt data.

Fix:

Tricky. If you take several images of the same field, you could dither very little between frames and hope the ghost doesn't move much, so that it is easily identifiable and well defined in the final combined image. Alternatively, you can try dithering by a lot to move the offending star around and then hope the ghost image changes position enough that any transient features are removed when median combining the images later.

Fig.7



Telescope	CTIO 4m
Date	5/20/1998
Instrument	BTC (1 chip)
Filter	R
Exposure Time	480 sec

Problem:

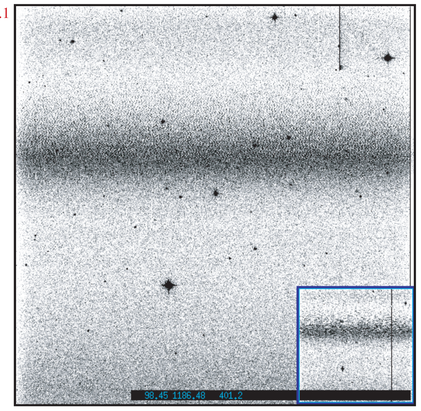
This is an example of an airplane going through the field of view during the exposure. Note the different intensities of the "tire tracks" going through the image, due to the different colors and intensities of the lights on the bottom or perhaps wings of the aircraft.

Fix:

Take another exposure. If the problem persists, you may have to contact ATC (air traffic control) ...

Bias Ramping

Fig.1



Telescope	MDM 1.3m
Date	9/29/95
Instrument	Nellie
Filter	V
Exposure Time	25 sec

Problem:

Often on this run, bias ramping structure would show up in low level images such as standard star frames. The ramping structure varied from image to image and was not always present. Although this looks terrible, the bias level is only varying by a small amount (2.5%) which is why it only showed up in short exposures with low signal.

Fix:

The images often can be fixed during the processing because the same structure usually shows up in the overscan region. Subtracting out a fit of the overscan region frequently works well. The cause of the problem, however, lies within the electronics, so checking for things like loose cables might also be a good idea.

a plot along the overscanning showing the same ramping

the overscan subtracted image

a second example of ramping

a third example of ramping

Return to the "CCD Features" Directory

Return to the Main Directory

A typical webpage in the database.

The Location of the Database

The Observational Mishaps Database can be accessed at
http://www.astro.lsa.umich.edu/mishaps/mishaps.html.

It is also directly accessible from the University of Michigan Astronomy Department Home Page, whose URL is
http://www.astro.lsa.umich.edu.

Additional Remarks

We have created a database of images which are deteriorated by the effects of various mishaps encountered during astronomical observing runs. Its structure was designed to help users quickly identify the cause of the poor image quality, thus saving telescope time. In addition to being widely accessible via the WWW, the advantage of such an on-line catalog is its versatility. Unlike a printed catalog, the on-line version can very easily be updated, corrected, and expanded, so that everytime the database is accessed the user will find it in its most up-to-date form.

Due to the practically infinite number of possible problems during observing runs, this collection is clearly far from and impossible to complete. Its usefulness, however, is directly related to the number of examples it contains, and therefore we would appreciate any contributions by the astronomical community in the form of examples which might fit into this collection. Instructions for the submission of such images are given in the database.

Furthermore, we realize that some of our interpretations of the mishaps, as well as some of our suggestions on how to improve the images, may be incorrect or incomplete. While it is our intention to regularly update and improve this database, we welcome any input about the database in general, its structure, or even individual examples.

We would like to express our gratitude to the following people who contributed to this project by supplying examples and/or providing explanations of some mishaps: Gary Bernstein, Mario Mateo, Eric Miller, Patricia Knezek, Kelly Holley-Bockelmann, Lynne Allen, Michel Festou, and Doug Welch.