Warren A. Keller

Inside PixInsight

The Patrick Moore Practical Astronomy Series

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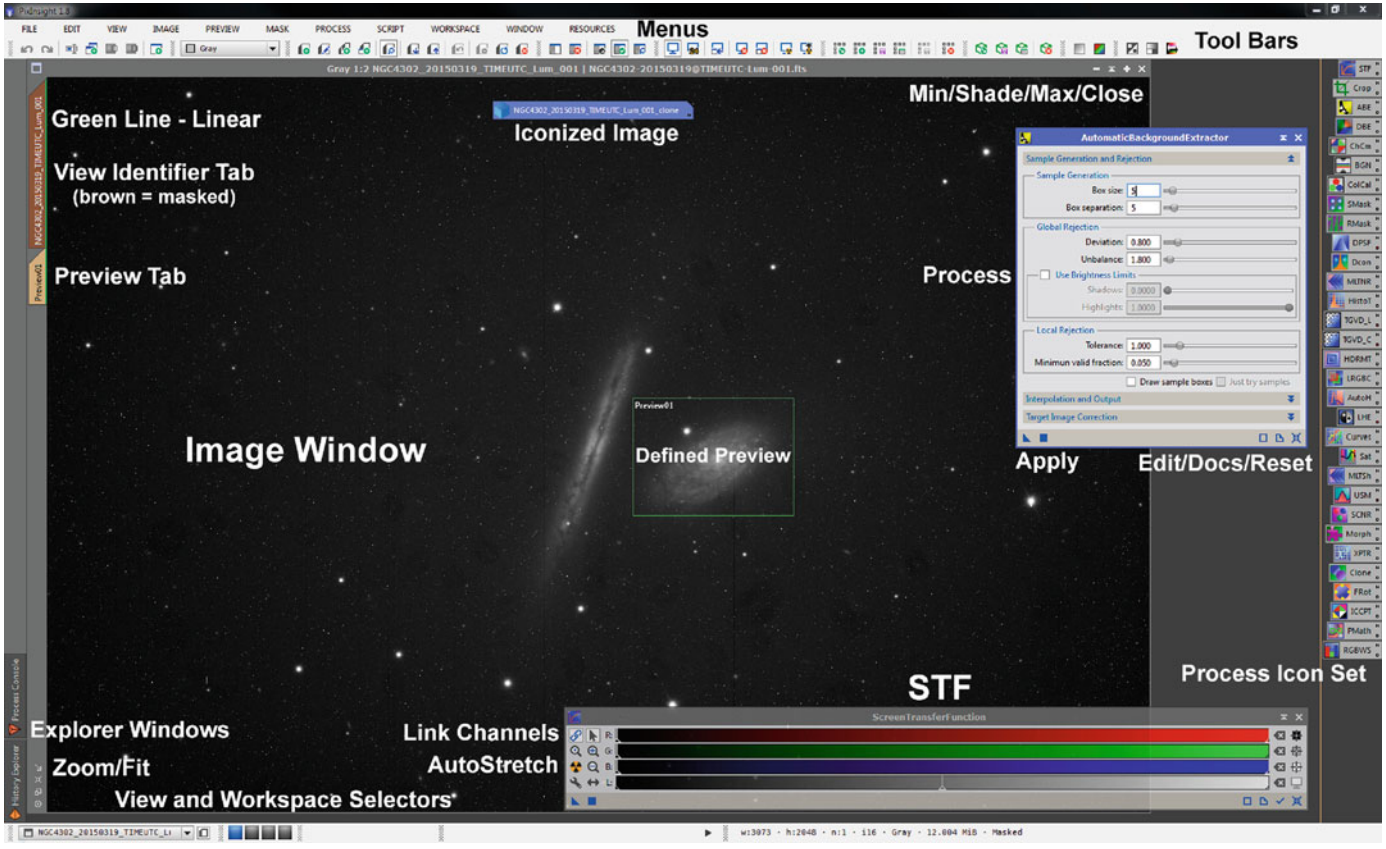

The PixInsight Workspace

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This book is dedicated to my late mother
Roslyn Pearl Schiff with all my love.
She would have been so very proud!
She was my greatest supporter, a world-class
musician and teacher, and the greatest friend
that those who knew her ever had.
She was equally fluent in the languages
of love and Debussy and awaited my latest
astro-image with genuine eagerness
and appreciation. We miss you mom!

Preface

If the astrophotography community presented an Academy Award for outstanding software tools, Pleiades Astrophoto's PixInsight would have earned that trophy. In an already crowded field of very capable image processing programs, PixInsight has risen above the crowd, taking it by storm. In addition to its state-of-the-art preprocessing capabilities, PixInsight is also a post-processing platform rivaling Adobe® Photoshop®, once the de facto standard for astrophotographers. Now, with PixInsight, astro-imagers, both amateur and professional, can take their images from raw data to finished fine art photographs using a single program.

PixInsight is the brainchild of software developer Juan Conejero of Valencia, Spain. Released in 2004 as limited edition freeware, it had evolved into the commercial product known as PixInsight Core by 2007. PixInsight supports Windows and Mac operating systems, as well as Linux and FreeBSD. As of the 2013 release of version 1.8 Ripley, PixInsight support was limited to 64-bit only. The decision was made to cease development of the 32-bit variety, as modern 64-bit processors are better suited for the program's intensive image processing algorithms. Visit the system requirements page at www.pixinsight.com for hardware recommendations. As of this writing, version 1.8.4 is available at a cost of 230€, which includes free updates for version 1 and email support.

PixInsight is structured much like an operating system, permitting users to develop their own processing modules using the C++ programming language. Scripting is also possible using the JavaScript language. User-created modules can be submitted to Pleiades Astrophoto for possible inclusion in the program. In addition to user submissions and those of Juan Conejero himself, the bulk of the contributions come from members of the official, mostly European PTeam, which includes electrical engineering doctoral candidate Carlos Milovic, professional astronomical image processor Vicent Peris, and others. Their collaboration has

resulted in over 150 cutting-edge tools, created exclusively "For astro-imagers by astro-imagers." This "For us/By us" mantra is pervasive throughout the PixInsight culture, and a visit to its lively user forum bears this out. Its developers and many enthusiastic users are convinced that this level of specialization is required for the demanding tasks of astronomical image processing.

PixInsight's closest competitor in the post-processing arena is Adobe® Photoshop®. And while Photoshop's power and versatility continues to be effectively adapted to the needs of astrophotographers by enterprising users, it is a generic editing program designed for everything from the graphic arts to the enhancement of terrestrial photographs. As a result, many of its tools are not useful for astro-imagers, who often purchase third-party plugins and automated Actions to expand the program's ability to better handle astronomical data. By comparison, all of PixInsight's tools are specifically designed for astronomical image processing, so the need for additional purchases of this type is unnecessary.

While a workflow consisting of multiple programs can be complementary, there is a bit of contention between the camps. PixInsight (PI) users tend to frown upon Photoshop's manual selections and painting features as a "Fast Food" approach to the discipline, while some Photoshop® zealots have the opinion that PixInsight presents too steep a learning curve to climb. In truth, any specialized software worth its salt requires significant time to master, and it is the goal of this book to considerably level the learning curve.

PixInsight's user interface offers a dizzying array of drop-down menus and submenus, and navigation would be daunting without the aid of adequate documentation. While, as of this writing, PI's official help file remains far from complete, a wealth of textual information exists in mouseovers that appear when the cursor is floated over a process dialog. Another excellent resource for learning the software is the aforementioned user forum, where tutorials are often posted by Juan Conejero or Vicent Peris. There too, answers to questions may be solicited from the PTeam and from advanced users. The forum also provides a place to post bug reports or items on your wish list that you'd like to see added to the software. New processes and scripts are announced there as well. There's even a gallery to share your images with others.

Several excellent video tutorials are available on the World Wide Web. Nearly every successful PixInsight user owes part of their victory to the free video tutorials of Ian "Harry" Page (Harry's Astroshed) and the commercial video series by IP4AP (Image Processing for Astrophotography). Before beginning this book in earnest, viewing IP4AP's free primer chapters (http://www.ip4ap.com) is strongly recommended. They will get you comfortable with navigating the user interface of the program. Additionally, PixInsight is being taught via workshops led by Vicent Peris and Carlos Milovic in both Europe and the Americas. While this book, however comprehensive, cannot hope to cover every possible scenario you may face in astronomical image processing, *Inside PixInsight*, in conjunction with these other valuable resources, will paint a complete picture.

Inside PixInsight is divided into four main sections—Preprocessing, Linear Post-processing, Nonlinear Post-processing, and Special Processing. The first section, Preprocessing, will teach you everything you need to know to produce calibrated, aligned, and stacked master image files. The middle sections of the book on Post-processing will help you transform those master files into works of art. The final section will address special processes such as creating mosaics and narrowband images.

While PI is capable of scientific analysis, the emphasis of *Inside PixInsight*, like PixInsight itself, is on the technical art of astrophotography and specifically the deep-sky variety. This book assumes you've already begun your journey in astroimage processing and does not attempt to teach all of its concepts from the ground up. Wherever possible, *Inside PixInsight* follows a chronological path, from the beginning of workflow to its successful conclusion. It is intended to be a practical guide, featuring the best choices for most situations but cannot present all the choices for the many variables you'll encounter in image processing. It is strongly suggested that you read the text in its entirety, especially in the early stages. While you might assume that a particular section doesn't apply to you, it will contain valuable information which does. Enjoy *Inside PixInsight*!

Buckhannon, WV Warren A. Keller

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This book would not have been possible, or even necessary for that matter, if not for the genius of Mr. Juan Conejero of Pleiades Astrophoto, the developer of PixInsight Core. I want to personally thank Juan for his support of this project.

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Thanks to everyone else who has supported me in my efforts—my wife Christine, my dog Jack, my many friends in astronomy, the thousands of viewers around the world of my video tutorial series, and last but not least—you the reader. Thank you all!

About the Author

Warren Keller has taught astro-image processing since 2005, via his website IP4AP.com (Image Processing for Astrophotography). His articles and images have been published in *Sky & Telescope and Astronomy* magazine, as well as many places on the World Wide Web including NASA's Astronomy Picture of the Day (APOD). Three of his large format prints were chosen for 2012's prestigious *Starstruck: The Fine Art of Astrophotography* traveling exhibit. He was the North American representative for Atik CCD Cameras and was a consultant to Celestron where he designed AstroFX software for the Nightscape CCD camera. Working part-time for Quantum Scientific Imaging (QSI), he was elected to the board of directors of the Advanced Imaging Conference (AIC) in 2015. Warren has presented at the Advanced, North East, Midwest, RAW, and CAPS imaging conferences and was the coordinator of the Southwest Astrophotography Seminar (SWAP) in 2013–2014. He has also spoken at SCAE, RTMC, the Black Forest, Texas, Okie-Tex, Winter, Green Bank, Almost Heaven, Apollo Rendezvous, and Hidden Hollow star parties.

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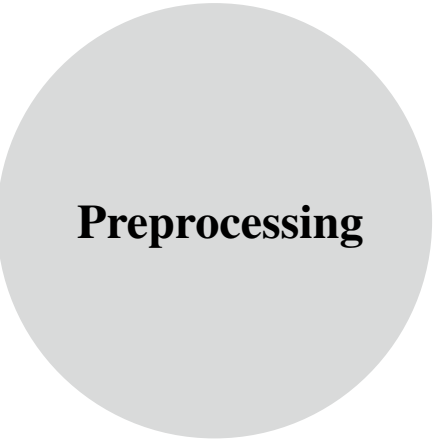

Chapter 1

Image Evaluation

Quality, deep-sky astrophotographs are achieved by digitally combining the signal present in multiple subexposures (subs). In this manner, inherent noise and other artifacts are attenuated, so that even the weak signal of dim regions becomes strong enough to be displayed and even enhanced. To that end, preprocessing, which may include image calibration, cosmetic correction, debayering, alignment, and image stacking must be performed accurately to ensure best results. In a perfect world, we could forge ahead with these tasks. In the real world however, it's good practice to evaluate the quality of our exposures before proceeding. While some imperfect subs may contribute to a good result, those with particularly poor attributes such as bad focus or tracking, weak contrast, or excessive artifacts such as airplane and satellite trails may best be discarded rather than permitted to adversely affect the stacked master file. PixInsight offers several resources for image evaluation.

Processes, Scripts, and Explorer Windows

PixInsight's tools are divided into two categories—Processes and Scripts. Processes are hard-coded tools developed primarily by the PTeam and written in C++ programming language. Scripts on the other hand, are open source, and changeable by an advanced user using the JavaScript language. While Scripts may be products of the PTeam, many are third-party contributions. Each is available via its respective drop-down menu at the top of the workspace, and also together from the View menu's Explorer Windows/Process Explorer. This window, along with five other

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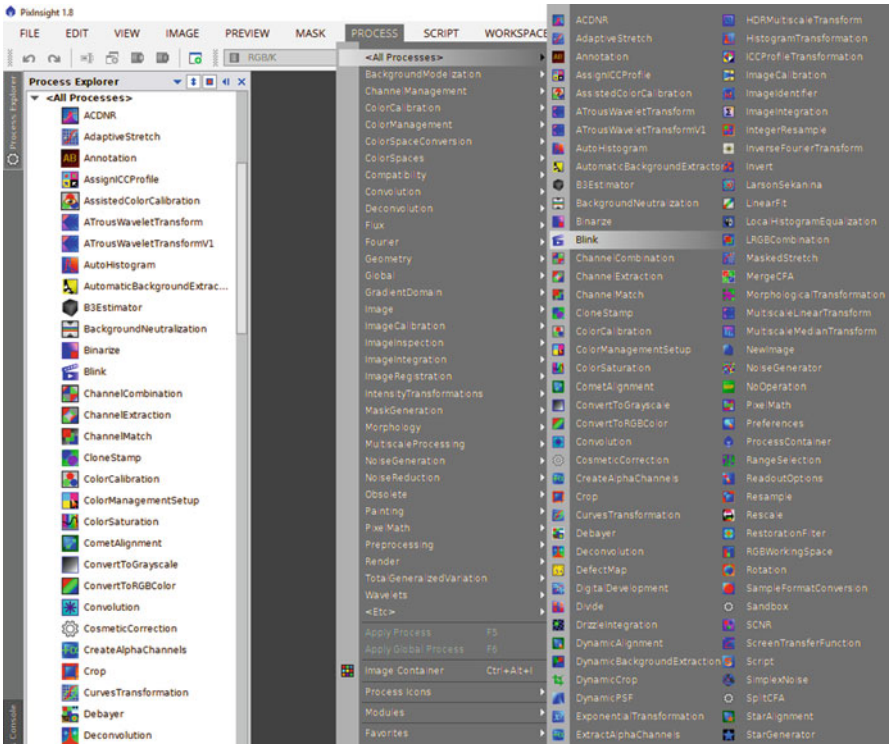

Fig. 1.1 At *left* (*white*) is the Process Explorer window. Note that Blink is listed alphabetically and available there, as well as from the All Processes menu at *right* (*gray*). Any process would also be listed under its specific submenu, in this case, ImageInspection

Explorer Windows can be opened, moved, or closed according to your preferences. For our foray into the program, we'll choose Blink, found under the Process menu's ImageInspection submenu (Fig. 1.1).

By the way, 'ImageInspection' isn't a typo—most of PI's functions are named with this conjoined convention (i.e. ImageInspection, AutoHistogram, etc.).

Blink

Blink is a digital version of the blink comparator of old, and helps us to either pass or fail exposures based on their visual characteristics. Upon opening, all of Blink's icons are grayed-out, with the exception of the folder icon at bottom-left. Clicking once, navigate to, and choose the images you wish to analyze, and then click Open. Blink will load the files and enable the other control icons (Fig. 1.2).

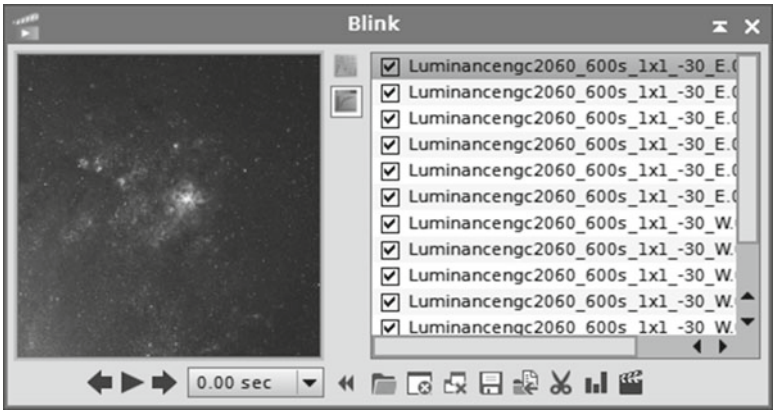

Fig. 1.2 Process Blink lets you quickly evaluate the quality of your subframes by displaying them in an adjustable, automatic continuous loop. In this way, problematic data can be easily identified and eliminated

During image load, something else happens that's hard to ignore. The Explorer Window that abruptly pops up is called the Process Console. The console is reminiscent of a DOS prompt, and while it may take some getting used to, get used to it, because you can't make it go away. Soon however, it will become a welcome and trusted resource, as it textually reports everything PI is doing in real-time. In this case, it provides minimal information about the files and the total load time. With more complex processes, it provides vital statistics that help the user dial-in the tool's settings (Fig. 1.3).

You can increase the delay in milliseconds of the Process Console's appearance via Edit/Global Preferences/Miscellaneous Process Settings. In many situations, the console will not be displayed if a large enough delay is set.

STF: ScreenTransferFunction

In the background is an image window named BlinkScreen (Fig. 1.4). You'll note that despite the highlighted image's linear state, its visualization appears as if it had been permanently stretched in a nonlinear fashion. This is a testament to PixInsight's ScreenTransferFunction (STF) Auto Stretch. Despite the data remaining linear (as captured by the camera), the visualization is superior to most other processing programs. It is this ability to see the data well that enables the user to perform several repair and preparatory functions before any permanent, nonlinear histogram stretch has been applied. More on the STF in the next chapter.

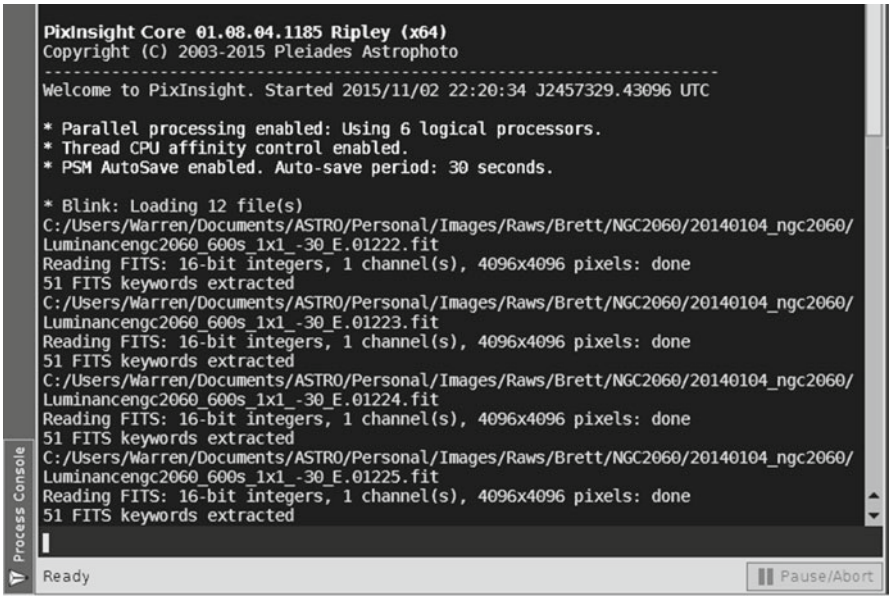

Fig. 1.3 The Process Console reports the progress of processes and scripts in real-time and other important metrics

If the contrast levels of individual images vary, double-click Blink's Compute AutoSTF button near the top of the dialog to reset the visualization of the stack. You can alternatively apply a temporary, automatic histogram transformation to all of the images by clicking the button at the top.

With the cursor placed in the image window, you can use the mouse's scroll wheel to zoom in for a closer examination. Floating the cursor over an area of interest, hold down the Ctrl key while zooming to keep it centered.

At this point, we would be inspecting the field of view for overall quality, and the stars for sharp focus and roundness. With the first image clicked and highlighted, you can blink manually through the file stack, using the mouse's scroll wheel, the up and down arrow keys of your keyboard, by clicking on file names, or by using the arrows in the gray column at left. These arrows are part of the automated blinker. You can begin automated blinking by clicking the play button or stop it with the pause button. Set the desired interval between images (between 0 and 5 s) in the drop-down menu.

Removing the default 'X' from a file name will exclude it from auto-blink. You can close a highlighted file with the Close Selected Images icon at the bottom of the dialog. Use Ctrl or Shift with a left-click of the mouse to highlight multiple files beforehand. Use the Close All Images icon to do just that. Be advised that Blink also has the ability to make a movie of say, a comet (Chap. 22).