LUNAR AND PLANETARY ASTROPHOTOGRAPHY WITHOUT A TELESCOPE: THE SUPER-ZOOM CAMERA METHOD. D. M. Burt, ASU School of Earth and Space Exploration, P.O. Box 876004, Tempe, AZ 85287-6004, dmburt@asu.edu.

Introduction: This presentation discusses a fun, fast, light-pollution ignoring method that I've been using for over 10 years to obtain astrophotos for education. I basically just point and shoot from my urban front yard, using a sturdy tripod and the camera self-timer. With digital photography you can instantly judge success. This presentation describes in detail some of the methods that have been most successful for me (compare Vorenkamp [1]).

My super-zoom digital astrophotography started with the Olympus C-2100UZ, which had an amazing (for the year 2000) 10X (38-380 mm equivalent) stabilized zoom lens made by Canon [2,3]. Its zoom range could be nearly doubled by attaching teleconverters and while at LPI I soon discovered that I could easily image craters on the Moon. Furthermore, 2 MP sensors of this vintage allowed handheld infrared photography using a simple IR filter, thus approximating the IR-sensitive cameras of the early Mars rovers [4].

For daily use, my "UZI" was soon replaced by various "bridge" cameras made by Panasonic and Canon. Of these, the 2012 Canon PowerShot SX50 HS [5], with its 50X telescoping zoom lens, was probably the best for astrophotography. I used it for several years, despite newer cameras with slightly more zoom range appearing from Canon, Panasonic, Nikon, and Sony (among other makes).

Then in 2015 appeared the Nikon Coolpix P900, with its 83.3X (24-2000 mm equiv.) zoom lens. It was topped in 2018 by the Nikon Coolpix P1000 with its 125X (24-3000 mm equiv.) zoom lens and the same 16 MP CMOS sensor. I bought both as refurbs, and found both superbly suited for painless lunar and planetary astrophotography. The P900 has since (2020) been replaced by the Coolpix P950, with identical specifications but different built-in software. What follows will mainly refer to using the Nikon P1000, which is little different from using the P900, or even the Canon SX50 or other super-zoom cameras.

Equipment: The super-zoom "bridge" camera you use for astrophotography should have a fold-out rear screen, allowing you to use the camera pointing straight up. Lower-end super-zoom cameras have a fixed rear screen and are much less suitable. They also may lack full-manual camera settings, needed for best results.

You will also need a sturdy photo tripod, preferably with a pan and tilt (three-way) head. Used all-metal tripods may be sturdier (and cheaper) than modern plastic tripods. An alt-az (geared) astronomy tripod with camera attachment should also work. Also look for a low stool to sit on while working at the tripod. Finally, if you want to photograph the Sun, a suitably-sized solar filter will be needed. I use one made by Baader using their solar film attached by friction to a 77 mm diameter short lens hood.

Techniques: For maximum sturdiness, set up the tripod at waist height using only the thicker, uppermost leg segments. Leave the pan head free to turn horizontally and tighten the vertical control. If photographing an object nearly overhead, shorten the tripod leg closest to you (w/o endangering stability). Set the camera self-timer to 10 sec. (3 sec. sometimes isn't enough) and turn off image stabilization. Allow the target to fully enter the FOV during the self-timer interval. Set color balance to "daylight" (illumination comes from the Sun). Set color intensity to neutral (for the Moon) or perhaps vivid if emphasizing color (e.g., for a lunar eclipse or the GRS of Jupiter). Set pixel res. and jpeg quality to max. and noise reduction to its lowest setting (or off) to maximize detail and sharpness (RAW option ignored). I leave sharpening alone, and sharpen afterwards in software. For maximum quality and detail, set the ISO to its lowest possible level (ISO 100 on the Nikon P1000). Set exposure metering and autofocus to spot for better control. For most purposes, turn off digital zoom, because it generally yields inferior images.

Another trick is to use completely manual camera settings (exposure and aperture). Ignore the camera's built-in settings for Moon shots, which are intended for hand-held use. For the Nikon P1000 set to ISO 100, lunar exposures might range from 1/13 sec. for a thin crescent up to 1/320 sec. for full, whereas planetary exposures might range from 1/13 for Saturn up to 1/500 or more for Venus. For maximum lunar detail, overexpose by about two steps, verging on complete burnout, and darken the image afterwards. For very dim lunar eclipses, use a lower zoom, a wider aperture, and ISO values up to 800. Exposures up to 1/2 sec. may be needed.

The minimal aperture the camera must use at maximum zoom can cause diffraction effects, leading to image softening. Therefore, full zoom Nikon P1000 images are somewhat less sharp than their extra zoom level might imply, compared to the P900. For the P1000 I always open up the aperture, if possible, when using less than the maximum zoom. This is necessary, for example, to image the full Moon or Sun. The lower F-stop can increase image sharpness.

To focus on the Moon, I use the camera autofocus independently for each shot. This is accurate and fast compared to manual focus. For focus on the larger, brighter planets, autofocus generally doesn't work (except sometimes on Jupiter, if its moons are close), so I lock the tripod on the planet, tilt the tripod on two legs until it is pointing at the Moon, autofocus at full zoom, then tilt the tripod back until the planet is back on the LED screen, then finish pressing the shutter. This is fast and highly accurate, if the Moon is somewhere near the planet in question (or at least visible in the sky). Dim planets such as Saturn may require several tries to reacquire after focusing on the Moon, but at least the focus is sharp (look for the Cassini Division).

In general, if the sky is hazy or cloudy, the weather is windy, or the stars are twinkling too much in a clear sky (poor seeing), you might want to wait for a better night. Even when conditions appear excellent (as they commonly appear at dusk), I generally take each shot at least 3 times, and bracket the exposure values at least 3 times too. That is, I take at least 9 photos, 3 at each exposure speed, and probably many more. This is a small investment in extra time, and partly insures against minor tripod vibrations, autofocus variations, and invisible atmospheric turbulence. Sometimes the sharpest photos are obtained during the first 5 minutes, before the camera begins to adjust to ambient temperatures. Although this method avoids using astronomical averaging (image stacking) software such as RegiStax or AutoStakkert, using conventional imaging software afterwards does greatly improve the images.

Photo Processing: Many image-processing programs are available, ranging from rather complex and expensive to free. Because it is free, simple, fast, and does a great job, I generally use the very popular FastStone Image Viewer for Windows [6]. (The creator does appreciate donations.) The adjustments I commonly use for lunar images are rotation (putting E at the top), cropping (to 16:9, especially for screen savers), curves, lighting, colors, levels, resizing, and sharpening (unsharp masking, trying not to overdo the effect). For the Moon, avoid using excess contrast, darkening the basalt-filled craters until they are nearly black. This is not how they look. They are actually somewhat brown, which why the Moon generally should not be processed in black and white

Processing the planets can depend on the image and planet, but generally involves the same adjustments plus considerable experimentation. Planets are shot at full zoom, so crop them by the same amount for a consistent scale. For Fig. 1, I used 2X digital zoom, then compensated by downsizing the image.

Discussion: A modern super-zoom bridge camera is basically a tiny (cell-phone sized) sensor attached to an image-stabilized telescoping lens, plus built-in firmware. There exist multiple astronomical imaging alternatives, not discussed here. I use super-zooms because they are multi-purpose, fast, simple, and fun. Serious-level astrophotography can be a black hole for both money and time, although the results can be superb.

Conclusions: The advantages of using a super-zoom digicam for lunar and planetary astrophotos, in addition to being fast and fun, are first, that you may already own one for nature or bird photography, second, that they are readily available refurbished, third, that the camera, new or used, is the only major investment, fourth, that the other accessories needed (tripod, stool, lens hood, and solar filter) are non-astronomical or cheap, and fifth, that very good post-processing software can be free and is probably already familiar if you are a photographer. The disadvantages are first, that the magnification is strictly limited by the pixel resolution and camera zoom (you can't swap out eyepieces or lenses) and second, that the tiny image sensors are not terribly light-sensitive, largely limiting your photos to the Moon and brighter planets. Ambient light pollution already subjects you to the same limitations in urban areas.

References: [1] Vorenkamp, T. (2019), https://www.bhphotovideo.com/explora/photography/tips-and-solutions/superzoom-moon-these-10-tips. [2] Johnson, A. (2017), https://www.dpreview.com/articles/8632430610/throwback-thursday-the-olympus-c2100uz. [3] Askey, P. (2000), https://www.dpreview.com/reviews/olympusc2100uz. [4] Burt, D.M., (2005), *LPS XXXVI,* Abstract #1705. [5] Keller, J. (2013), https://www.dpreview.com/reviews/canon-powershot-sx50-hs. [6] FastStone Corp (2022) https://www.faststone.org/index.htm.

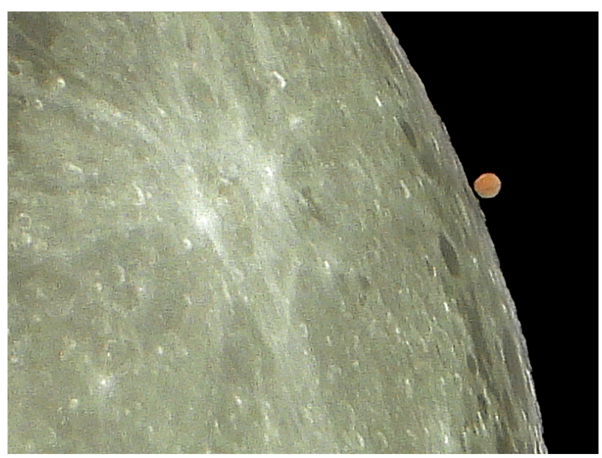

Fig. 1: Snapshot of the occultation of Mars by the full Moon, Tempe, AZ, 12/07/22, with Mars just emerging at 08:35 PM MST. Nikon Coolpix P1000, ISO 100, 1/160 sec., F8, 2X digital zoom (downsized).