VIDEO ASTRONOMY WITH CCTV CAMERAS

Cheap!

GOING DEEPER ON A BUDGET

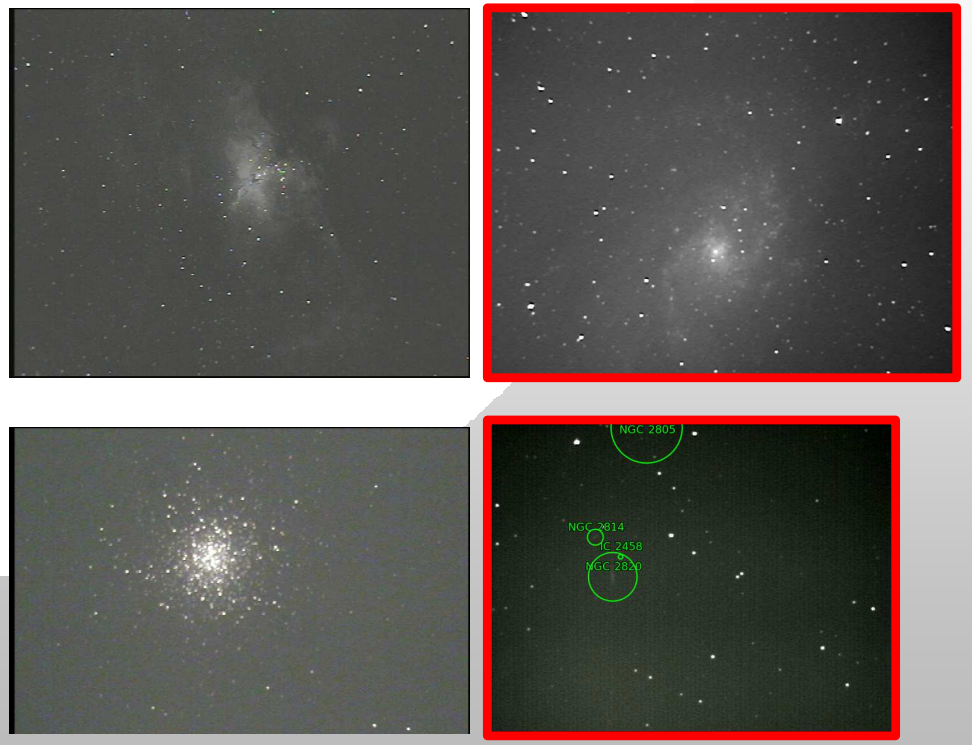
WHAT IS VIDEO ASTRONOMY?

- ASTRONOMY WITH VIDEO CAMERAS, BUT…
  - **NOT TRADITIONAL IMAGING**
- REAL-TIME/LIVE VIEW OVER IMAGE QUALITY
- THINK: "ELECTRONIC EYEPIECE."
- A NEW WAY FOR THE PUBLIC TO VIEW THE UNIVERSE

WHAT WILL CCTV CAMERAS ALLOW ME TO "SEE"?

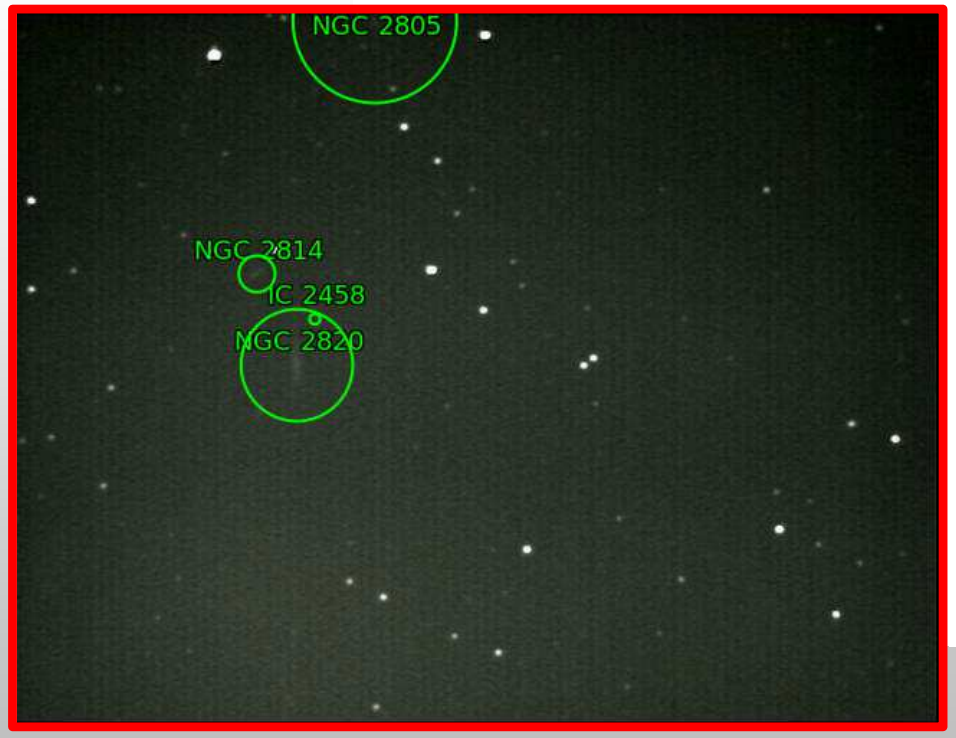
FROM YOUR OWN (LIGHT POLLUTED) BACK YARDS:

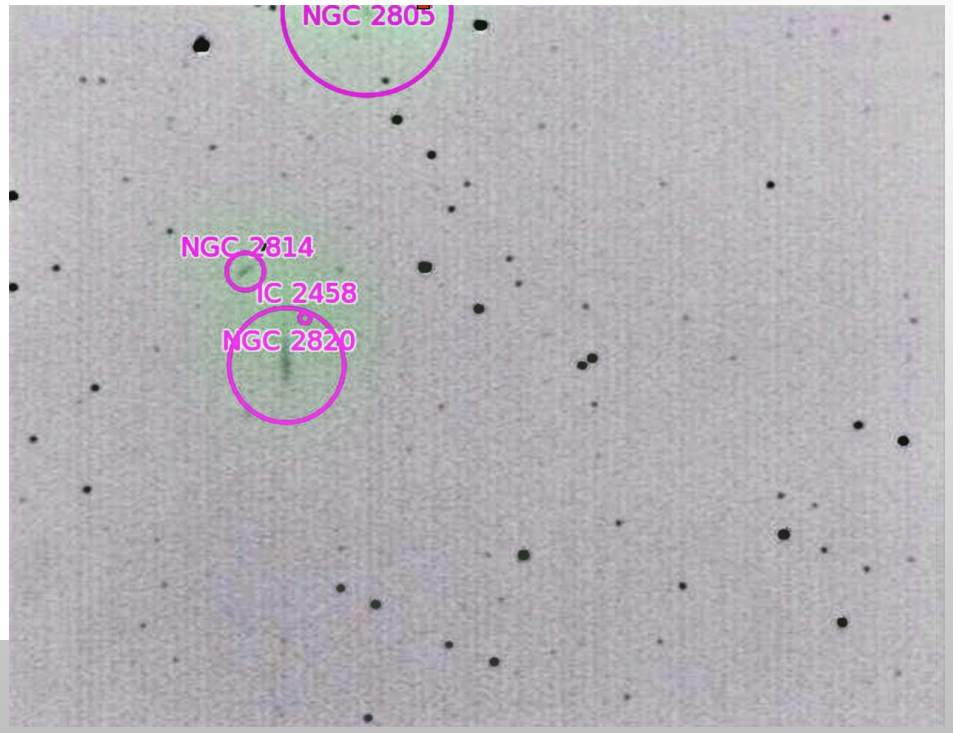
- THE EAGLE NEBULA
- SPIRAL ARMS AND STAR-FORMING REGIONS IN M31, M33, M51
- RESOLVABLE STARS IN GLOBS,
  - "SEE GLOBS, NOT BLOBS!"



Clockwise: ST80 (12nm H-a), 6" mak-newt (R#29) *livestack*, C8, 8" TPO newt (baader UHC) *livestack*

WHAT WILL CCTV CAMERAS ALLOW ME TO “SEE”?





MAG. 14-15 GALAXIES (NGC2814, MAG 14.4, IC2458 MAG 15.5)


WHERE
TO
GET
ONE

WHERE CAN I GET ONE?

ASTRONOMY OPTIMISED SOLUTIONS:

1. REVOLUTION IMAGER
   - WWW.REVOLUTIONIMAGER.COM
   - FULL, BATTERY-OPERATED OBSERVING KIT, ~~$299~~,**$250** AVAILABLE AT RTMC.
   - EFFIO-A BASED NOW

2. MALLINCAM MICRO-EX/SUPER-MICRO
   - HTTP://WWW.MALLINCAM.NET
   - STAND-ALONE **$99** / **$109**,
   - OBSERVING KIT **$250**

Still cheaper than premium eyepieces

CCTV FEATURES - WHAT TO LOOK FOR

IF YOU DECIDE TO GO LOOKING YOURSELF...

- **ANALOG OUTPUT OR "CVBS"** (COMPOSITE VIDEO) NOT "AHD" OR "IP"
- **"3D-DNR" THIS IS THE CCTV** TERMINOLOGY FOR ON-BOARD STACKING.
- **"SENSE-UP", "DSS", OR "DIGITAL SLOW SHUTTER"** - CCTV TERMINOLOGY FOR LONG EXPOSURES. EXPRESSED AS A MULTIPLE OF THE FRAME RATE. (E.G FOR PAL 1/50, 50X = 1 SECOND, 256X = 5.12 SECONDS)
- **CCD VS. CMOS.** CURRENTLY THE CCD SENSORS IN CCTV TEND TO BE MORE SENSITIVE THAN THE CMOS SENSORS BEING OFFERED NOW (SONY 811/810 AND 673/672 ARE COMMON)
- **LOW RESOLUTION** = BIGGER BUCKETS
- **DSPS**: DIGITAL SIGNAL PROCESSORS, ONBOARD COMPUTERS, MANY AVAILABLE, BUT THESE ARE THE FEATURES TO LOOK FOR
- **"STARLIGHT"** THE TERM THE CCTV INDUSTRY SEEMS TO USE FOR CAMERAS WITH LOW-LIGHT SENSITIVITY (ALSO CALLED DAY/NIGHT)

CCTV FEATURES - WHAT TO LOOK FOR – DSPS (DIGITAL SIGNAL PROCESSING)

RELATIVELY FEW DSPS OUT THERE, THESE ARE SOME TO LOOK OUT FOR:

1.“RJ11” - THIS WAS THE DSP IN THE ORIGINAL (R1) REVOLUTION IMAGER, MALLINCAM AND OTHER LN300 BASED CAMERAS.

2.“RJ10”, “802”, “803” - ALTERNATIVE TO RJ11 (R2) REVOLUTION IMAGER

3.SONY EFFIO-A (4151) AND OR EFFIO-V (4141) - NEW REVOLUTION IMAGER USES THIS DSP, CAN BE FOUND EASILY WITH ICX811 AND ICX673 CCD.

What is DSP

Digital signal processing cameras use a DSP chip to digitize analog video streams. Analog video streams are generated by charge-coupled device -- or CCD -- chips, which DSP chips then convert into a digital video signal. DSP cameras provide a number of notable advantages over analog cameras, including increased brightness, added stability, greater sharpness and resolution, greater power efficiency, reduced sensitivity to noise and more

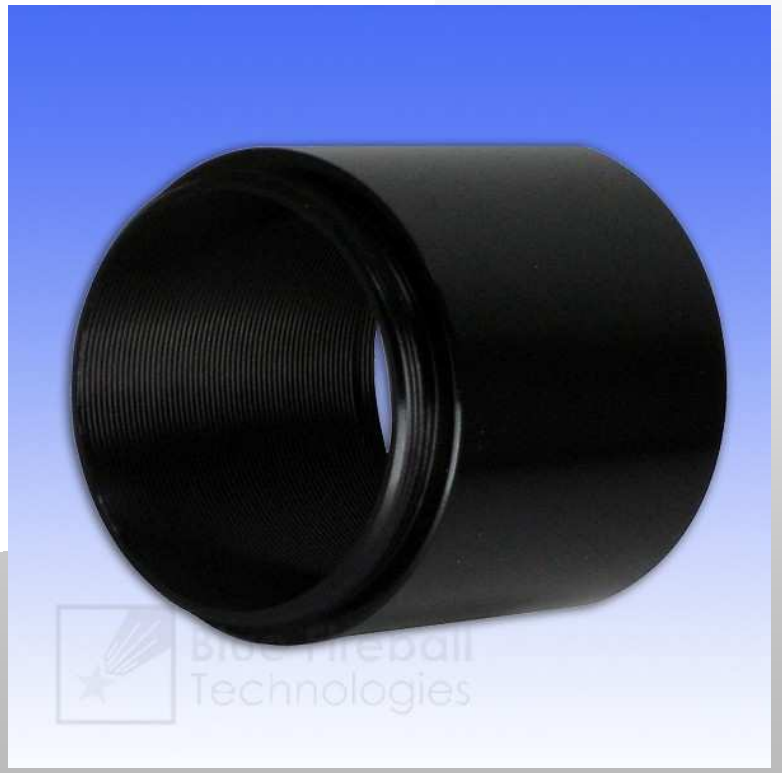
WHAT TO LOOK FOR - PAL VS. NTSC

1. THE PAL OUTPUT CAMERAS USUALLY HAVE SLIGHTLY LONGER EXPOSURE TIMES
2. THE PAL OUTPUT CAMERAS ON THE RJ11 AND RJ10 DSPS TEND NOT TO EXHIBIT LOSS OF COLOUR ON LONG EXPOSURES
3. THE PAL OUTPUT CAMERAS HAVE A SLIGHTLY HIGHER RESOLUTION

ACCESSORIES INCLUDED

HOW DO I ATTACH IT TO MY TELESCOPE?

1. C-MOUNT TO 1.25" ADAPTER. MOST BOXED CCTV CAMERAS HAVE A "C MOUNT" THREAD.
2. SOME BOX CAMERAS CAN BE INSERTED DIRECTLY INTO A 2" FOCUSER



'SCOPE REQUIREMENTS

1. THE MOST IMPORTANT FEATURE OF YOUR SCOPE IS THE **FOCAL RATIO**, MORE SO THAN APERTURE. THE FOCAL RATIO ALONE WILL AFFECT THE BRIGHTNESS OF DSO'S, YOUR APERTURE WILL AFFECT THE *SCALE AND RESOLUTION* OF THE DSO.
2. **TRACKING**: DUE TO LIGHT POLLUTION AND THE SENSITIVITY OF THE CAMERA LOW EXPOSURE TIMES WILL PROBABLY BE USED, THIS MEANS THAT TRACKING ACCURACY IS NOT ALL THAT IMPORTANT. AND WITH SMALL, FAST SCOPES WITH A WIDE FOV, **EVEN NON-TRACKING MOUNTS CAN BE USED**. (TRACKING ISSUES CAN BE OVERCOME BY USING LIVE STACKING)

FOCAL REDUCTION

- "SLOW" SCOPES (LONG FOCAL LENGTH) CAN BE MADE FASTER WITH THE AID OF FOCAL REDUCERS
- FAST SCOPES CAN BE MADE EVEN FASTER, TOO.
- DOBS/NEWTS: BEWARE, BACK FOCUS ISSUES.
- FOCAL REDUCERS ARE INCLUDED IN SOME OF THE PACKAGES OUT THERE (REVOLUTION IMAGER, MALLINCAM)
- 1.25" 0.5X FOCAL REDUCERS CAN BE OBTAINED FOR $20-$40

OTHER ACCESSORIES FOR THE R2

- REVOLUTION ALL-SKY - WIDE ANGLE LENS
- 25 FOOT STANDOFF CABLE
- USB VIDEO CAPTURE ADAPTER (FRAME GRABBER)

USEFUL FILTERS

- LIGHT POLLUTION AND UHC FILTERS (WHICH YOU MAY ALREADY OWN)
  - SOME CONTAIN IR BLOCK ALREADY (SKYGLOW FILTER)
- IR BLOCK FILTERS
  - FOR SHARPER FOCUS
- IR PASS FILTERS
  - USEFUL FOR GALAXIES
  - **RED #25 OR #29 CAN ALSO BE USED (BIG BANG FOR YOUR BUCK)**
- H-A OR OTHER NARROW-BAND FILTERS
  - GREAT ON NEBULA, $$$$

USAGE

REMOTE CONTROLS

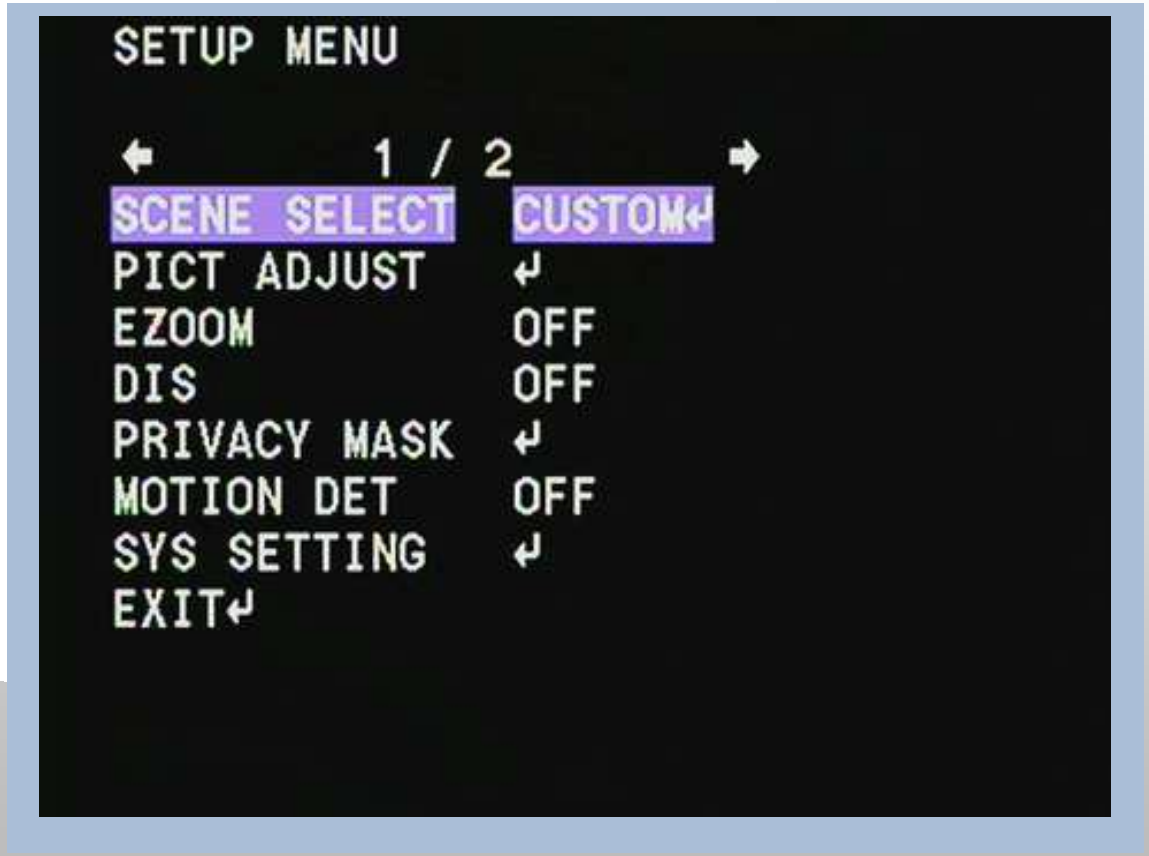
- MOST CAMERAS HAVE 5 BUTTONS ON THE REAR FOR USING THE OSD
- SOME SUPPORT A “UTC” REMOTE (REVOLUTION IMAGER)
- SOME ARE PRE-WIRED FOR PC CONTROL (MALLINCAM)
- NOTE: REMOTE CONTROLS AND SCREENS VARY AMOUNG CAMERAS

HOW TO VIEW LCD/TV VS. COMPUTER

- WITH COMPOSITE VIDEO OUTPUT THE IMAGE CAN BE VIEWED ON A BASIC PORTABLE LCD SCREEN OR EVEN A TV. NO COMPUTERS, NO BUGS, POORLY SCHEDULED UPDATES, ETC.
- OR A "FRAME GRABBER" LIKE AN "EZCAP" ($5-$20) CAN BE USED TO CAPTURE FRAMES ONTO A PC, OPENING UP ADDITIONAL OPPORTUNITIES WITH SOFTWARE.
  - "UVC" EASYCAPS REQUIRE NO DRIVERS ON MOST OS
- OR EVEN: A PROJECTOR

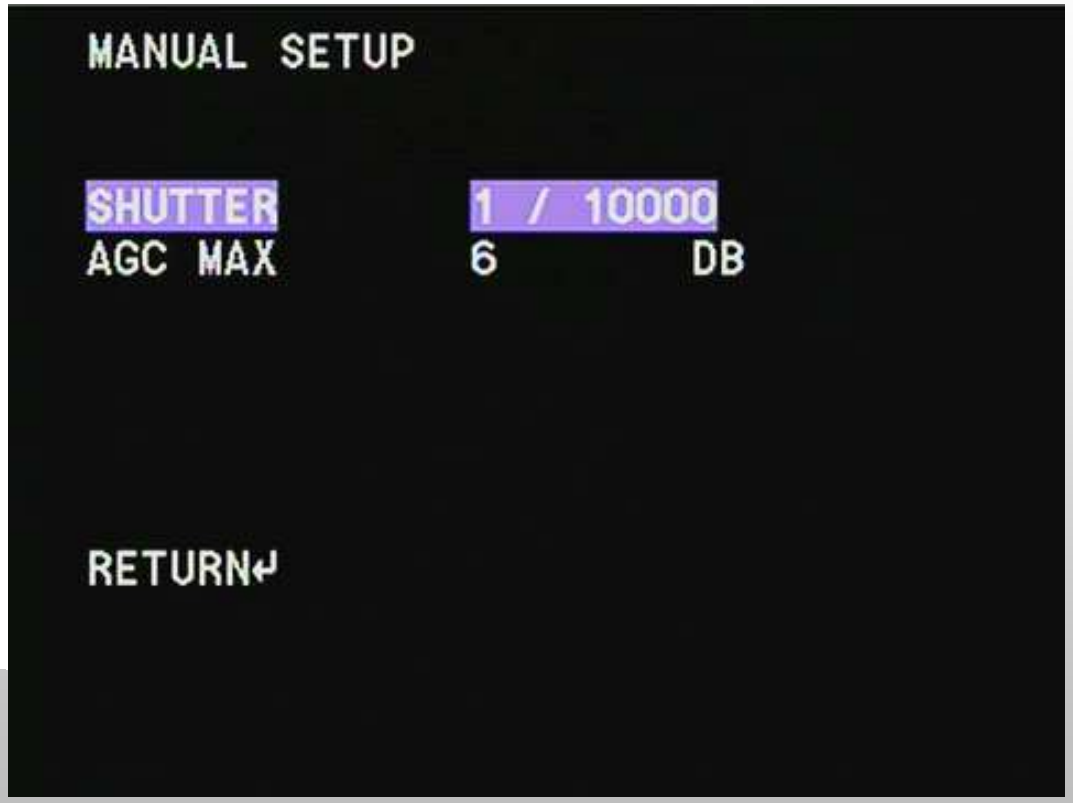
USING THE CAMERAS

- CAMERA SETTINGS ARE ALTERED USING THE ON-SCREEN DISPLAY MENUS USING THE BUTTONS OR REMOTE (CAMERA MENU AND SETTING SCREENS VARY WITH THE CAMERA



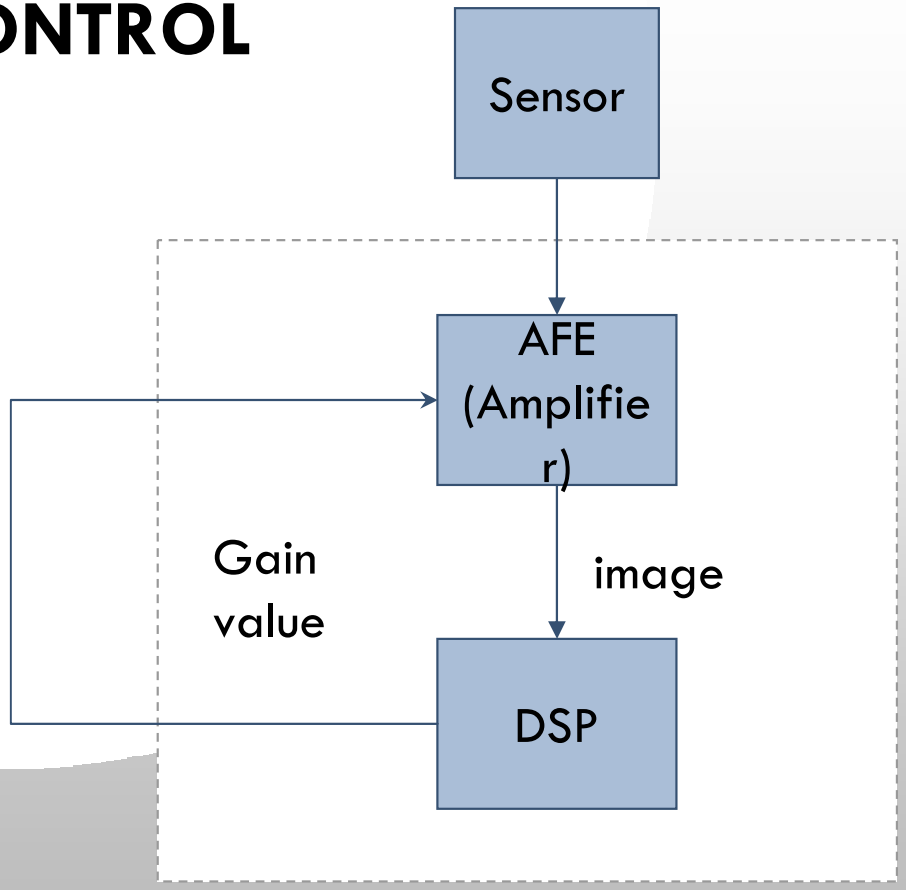
EXPOSURE TIME

- EXPOSURE TIME IS USUALLY SET USING “DIGITAL SLOW SHUTTER” OR SENSE-UP SETTINGS AS A MULTIPLES OF THE VIDEO FRAME-RATE. FOR NTSC MULTIPLES OF 1/60 AND PAL MULTIPLES OF 1/50.
- FOR EXAMPLE ON PAL CAMERAS, X256 = 5.12 SECONDS



AGC - AUTOMATIC GAIN CONTROL

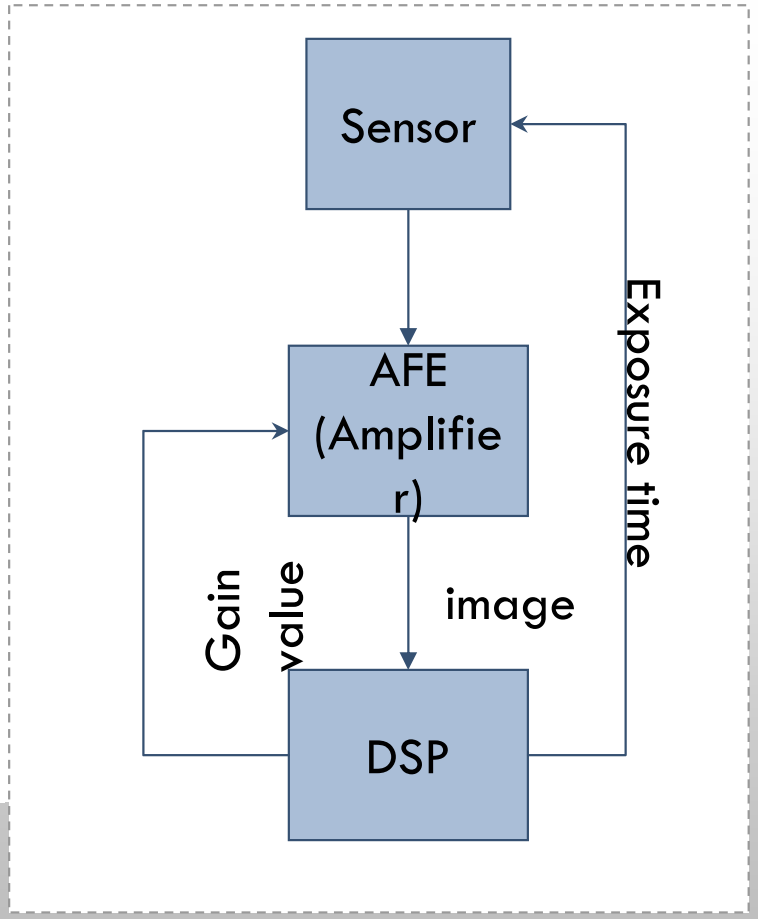
- MOST CAMERAS FEATURE SOMETHING CALLED “AGC.”
- MOST CAMERAS WILL APPLY A MAXIMUM X DB OF GAIN TO THE IMAGE TO SATISFY A USER SPECIFIED BRIGHTNESS SETTING
- THE EFFIO-A ALLOWS YOU SET A GAIN CEILING OR A FIXED GAIN VALUE (MANUAL VS. FIXED EXPOSURE MODE)
- RJ10/RJ11 CAMERAS OFFER LOW-MEDIUM-HIGH AGC CEILINGS.
    - CAMERA CAN BE CONVINCED TO APPLY MAXIMUM GAIN BY SETTING BRIGHTNESS TO HIGHEST SETTING



Loop until image brightness satisfies brightness setting

“SENSE-UP” (INTERNAL STACKING)

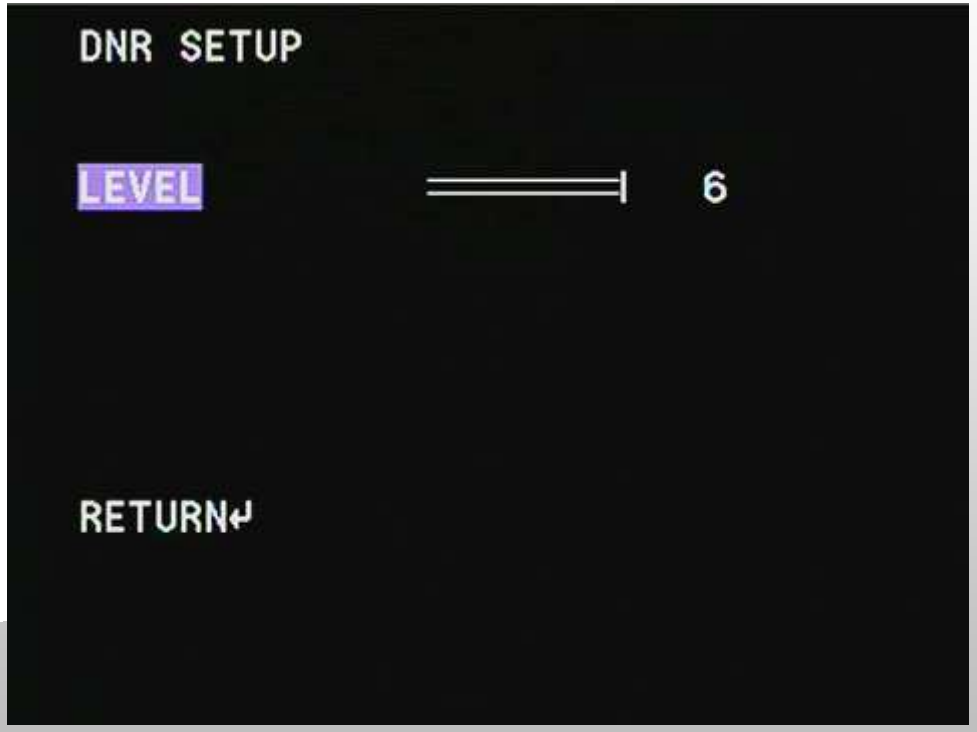
- SIMILAR FEEDBACK-LOOP AS AGC BUT ALSO BRINGS EXPOSURE TIME/SHUTTER SPEED INTO THE EQUATION.
- SOME CAMERAS JUST HAVE “SENSE-UP” AS AN ON/OFF SETTING (EFFIO-A/V)
- SOME CAMERAS (RJ10/RJ11/ETC) YOU SPECIFY THE EXPOSURE TIME CEILING (E.G X64, X256)



Loop until image brightness satisfies brightness setting

3D-DNR / IMAGE STACKING

- SOME CAMERAS OFFER “3D-DNR” WHICH IS AVERAGE-IMAGE-STACKING ON BOARD THE CAMERA
- NO REGISTRATION/ALIGNMENT SO MOUNT/STABILITY CAN MATTER ON “LONGER” EXPOSURES
- NUMBER OF FRAMES STACKED CAN BE CONFIGURED TO A MAXIMUM OF 5-6 DEPENDING ON CAMERA MODEL



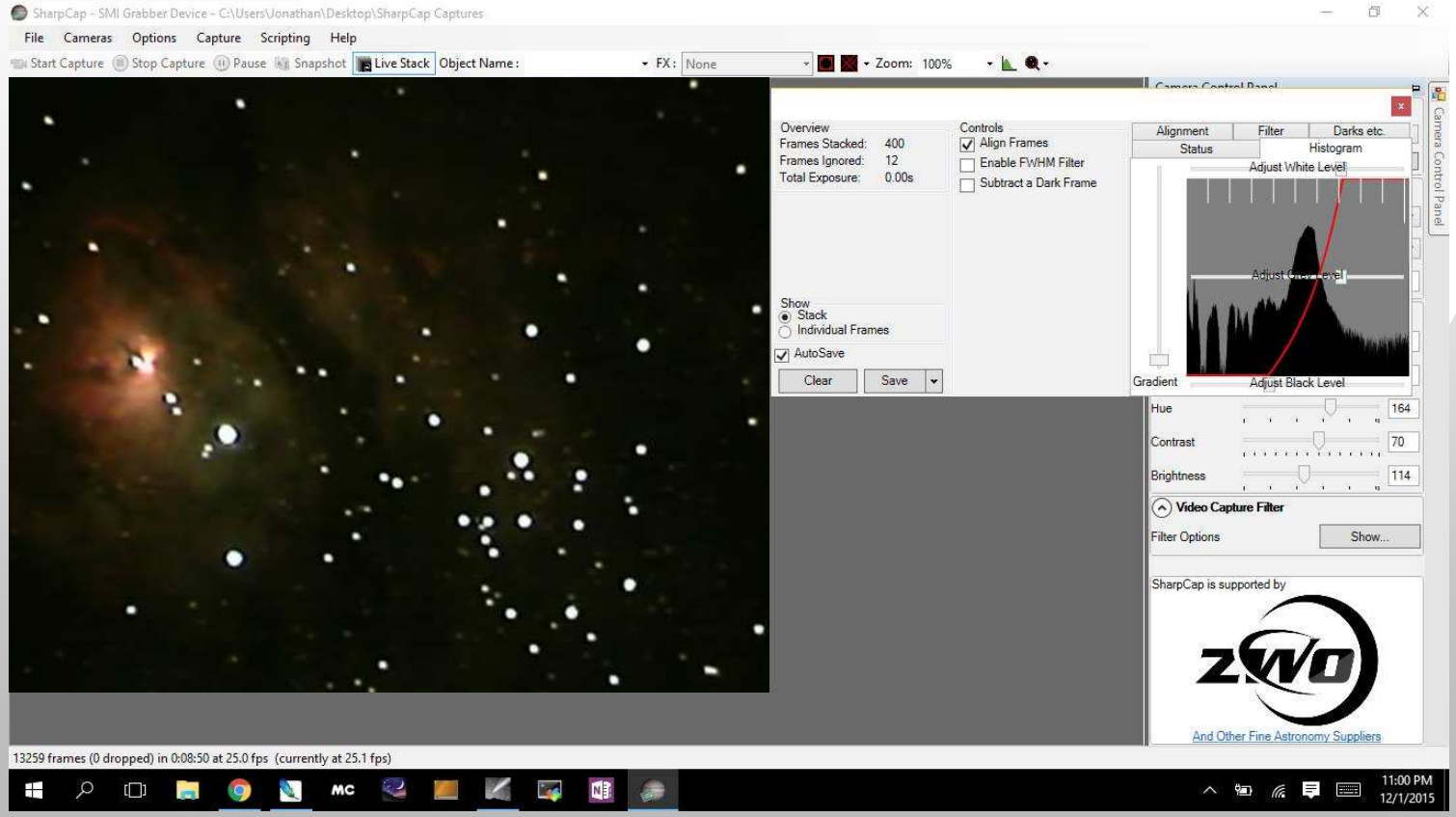
SOFTWARE
(OR: MORE BUCK BANGS)

SHARPCAP AND LIVE STACKING

- FREE SOFTWARE ($0!)
- VIDEO CAPTURE: SAVE FRAMES, VIDEO, ZOOM.
- LIVE STACKING: WILL COMBINE AND ALIGN FRAMES FROM THE VIDEO CAPTURE DEVICE
  - WILL ENABLE YOU TO SEE EVEN DEEPER
- NEW FEATURES ADDED REGULARLY

http://www.sharpcap.co.uk/

SHARPCAP LIVE STACKING PROCEDURE



1. click “live stacking”
2. select “reduce noise” in “Filter” tab.
3. Adjust histogram to taste.

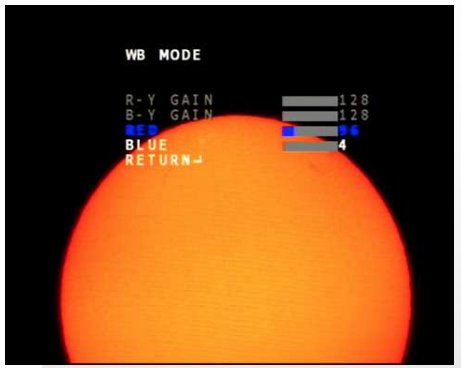
Visible spiral arms, star forming regions, 6” scope, “RED ZONE”, **less than two minutes.**

Use Photoshop or Lightroom (free) to enhance photos)

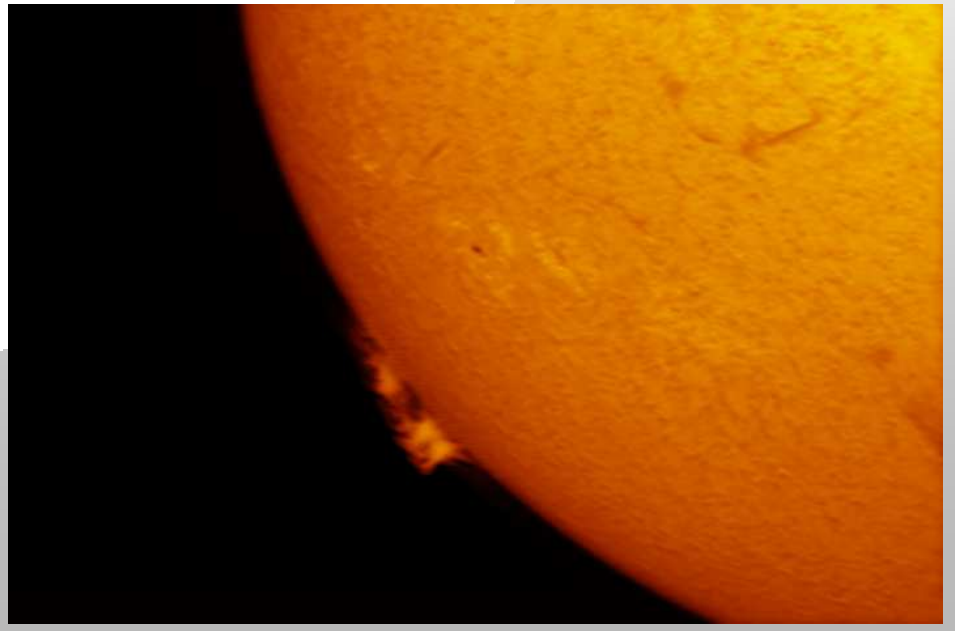
PLANETARY IMAGING

- SMALL CHIP SIZE AND PIXEL SIZE MAKE IT USEABLE FOR PLANETARY IMAGING
- THE 6MICRO PIXEL SIZE MEANS A GOOD FOCAL RATIO IS ABOUT F/30 FOR PLANETARY IMAGING
- COMBINED WITH AN EASYCAP GRABBER 30 FRAMES/SEC CAN BE CAPTURED AND PROCESSED WITH REGISTAX/AUTOSTAKKERT

SOLAR ASTRONOMY "FUN WITH OUR SUN"



1. CCTV CAMERAS CAN WORK VERY WELL IN H-A SOLAR TELESCOPES DUE TO ITS EXCELLENT SENSITIVITY IN THE RED RANGES
2. COLOUR BALANCE CAN BE ALTERED TO GIVE A "YELLOW" LOOK TO H-A, **GREAT FOR OUTREACH**.
3. ALSO WORKS WELL WITH A BARLOW TO IMAGE SOLAR FEATURES 'TRADITIONALLY' USING REGISTAX, ETC.
4. THESE IMAGES TAKEN WITH A CORONADO PST. LN300 REACHES FOCUS. OTHER CAMERAS CAN HAVE FOCUS ISSUES IN THE PST

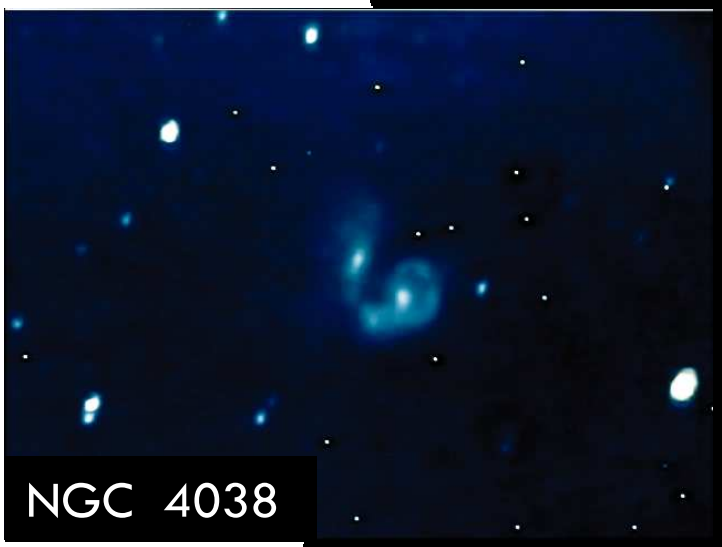


BROADCASTING & SHARING (THRU WIFI TO YOUR DEVICE)

- USING A USB CAPTURE CARD YOU CAN ALSO BROADCAST YOUR ASTRONOMY SESSIONS WITH THE WORLD USING:
  - GOOGLE HANGOUTS
  - YOUTUBE
  - NIGHTSKIESNETWORK.COM

R2 PICS

R2 PICS



CASE STUDY - M81 & M82

M81 & M82, Orion ST80 (80mm refractor)
MANUAL MOUNT. Sharpcap Livestacking.

CASE STUDY - NGC891 - RED FILTER

Walnut, CA skies, 6” Mak-Newt.
GSO Red #29 Filter
(3D-DNR/Onboard Stacking)

Walnut, CA skies, 6” Mak-Newt.
GSO Red #29 Filter
(SharpCap Live Stacking)

CASE STUDY - *M51* - *HORRIBLE* CONDITIONS

M51 - 6” ES Mak-Newt. Full moon, 80%+ humidity, clouds.
LiveStacking: shot through a thin cloud layer, in the direction of a streetlight

M51 - same scope, same skies - revolution imager, live stacking with histogram stretch

CASE STUDY - EAGLE NEBULA

ST80, 12nm H-a filter, no software

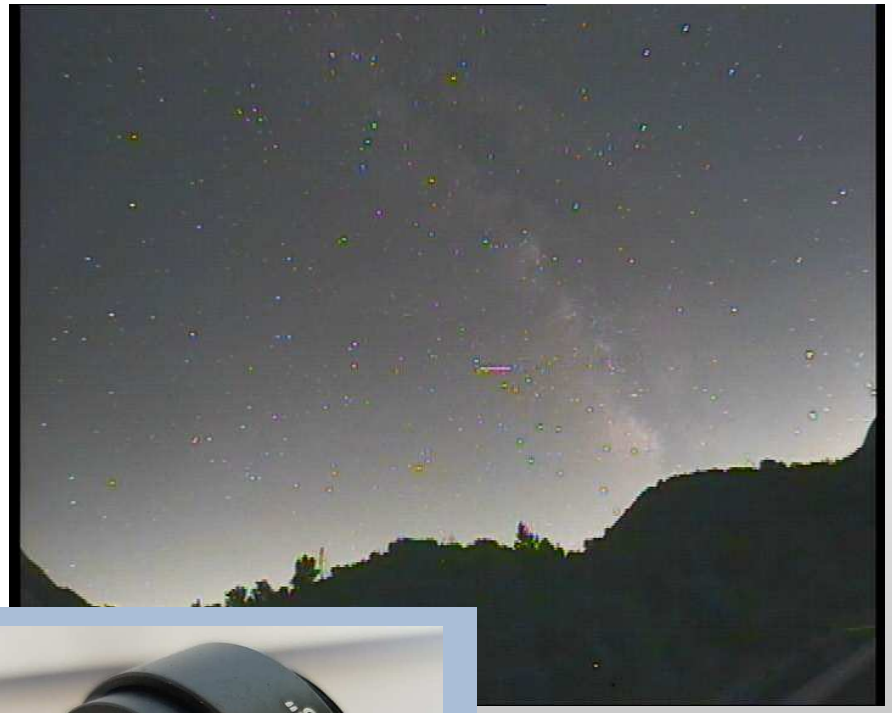
C8 with 0.5x focal reducer, no H-a filter

OUTREACH

- CCTV cameras provide a quick-and-easy setup for doing outreach, especially in solar.
- Also allows observing for those who are visually impaired

METEOR CAM

- THE ADDITION OF A CHEAP, WIDE-ANGLE CCTV LENS ($5 OR LESS) CAN ALSO BE USED TO RECORD IMAGES OF METEORS.
- SHARPCAP CAN BE PROGRAMMED TO PERFORM TIME-LAPSE
- SEE THE FOLLOWING PAPER: *"PERFORMANCE OF NEW LOW-COST 1/3" SECURITY CAMERAS FOR METEOR SURVEILLANCE"* DAVE SAMUELS, JAMES WRAY, PETER S. GURAL , PETER JENNISKENS



CONCLUSION

- MY $0.02 - IT'S NOT A MATCH FOR THE PLEASURE OF PHOTONS-TO-EYEBALLS
  - BUT IT'S ANOTHER TOOL IN THE TOOL CHEST FOR THE BACKYARD OBSERVER THAT WANTS TO GO DEEPER
- THERE ARE LP FILTERS AND EYEPIECES THAT COST MORE
- A NICE TOOL FOR THE TOOLBOX
- SHARPCAP'S LIVE STACKING CAN GIVE GREAT RESULTS ON INEXPENSIVE CAMERAS.
- DOWNSIDE YOUR SCOPE COLLECTION (GASP!)