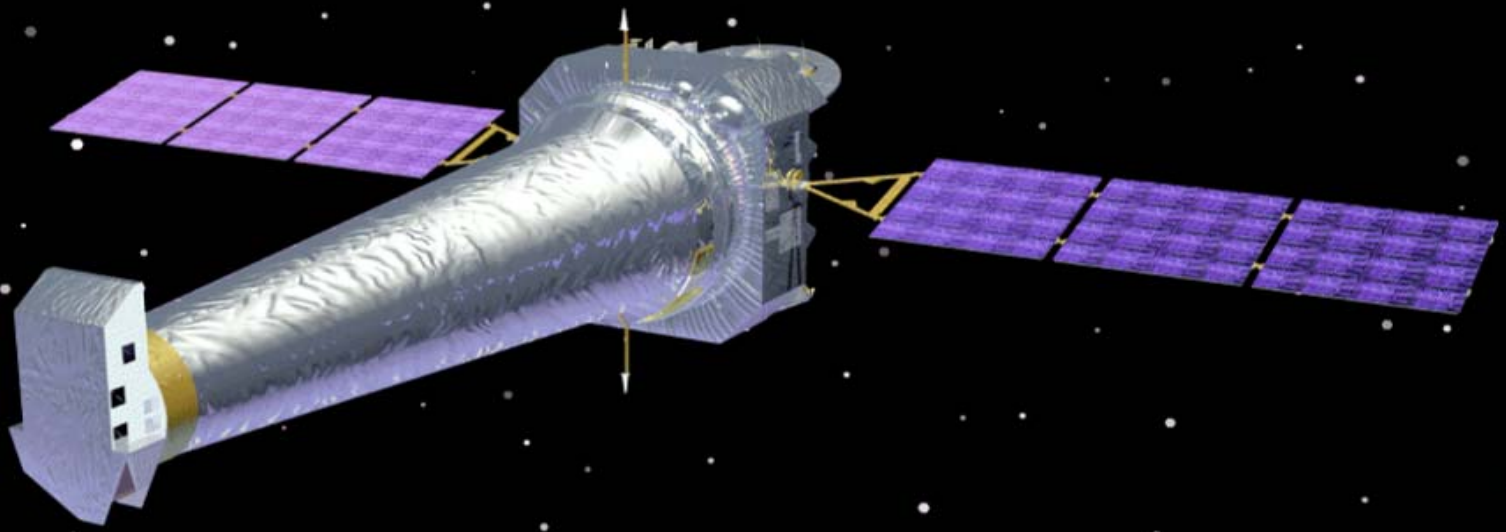
FINDING AND TRACKING THE CHANDRA X-RAY OBSERVATORY (CXO)



MICHAEL A. EARL

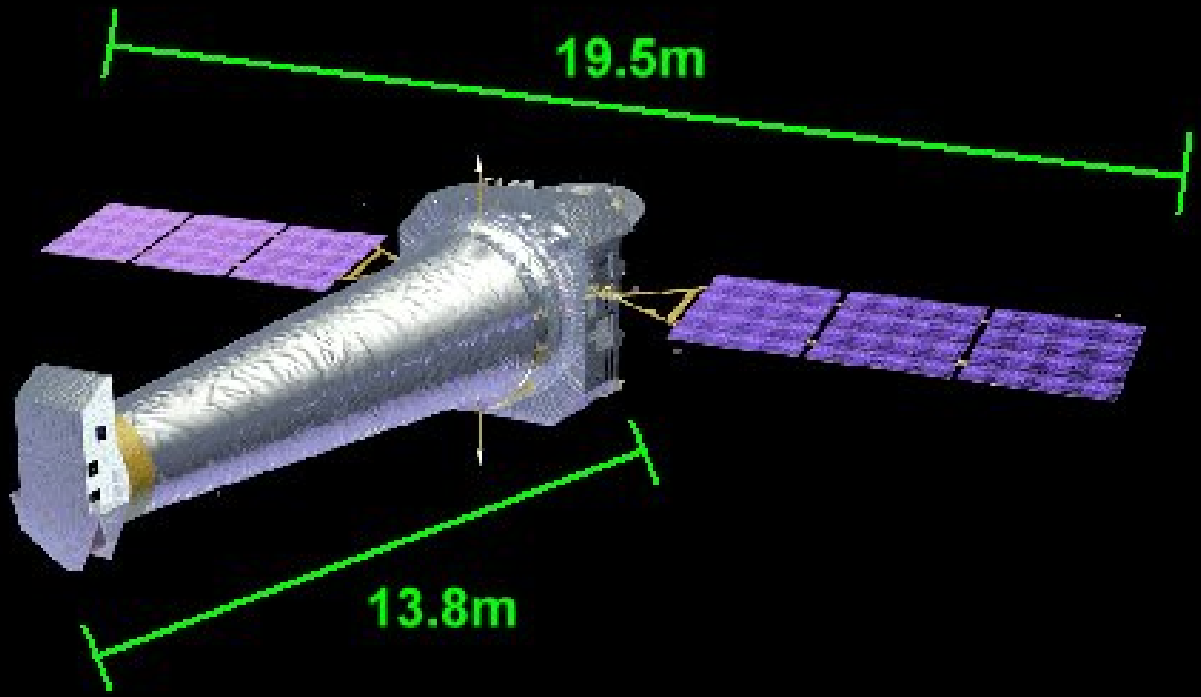
OTTAWA RASC MEETING

MARCH 3, 2006

ORBIT

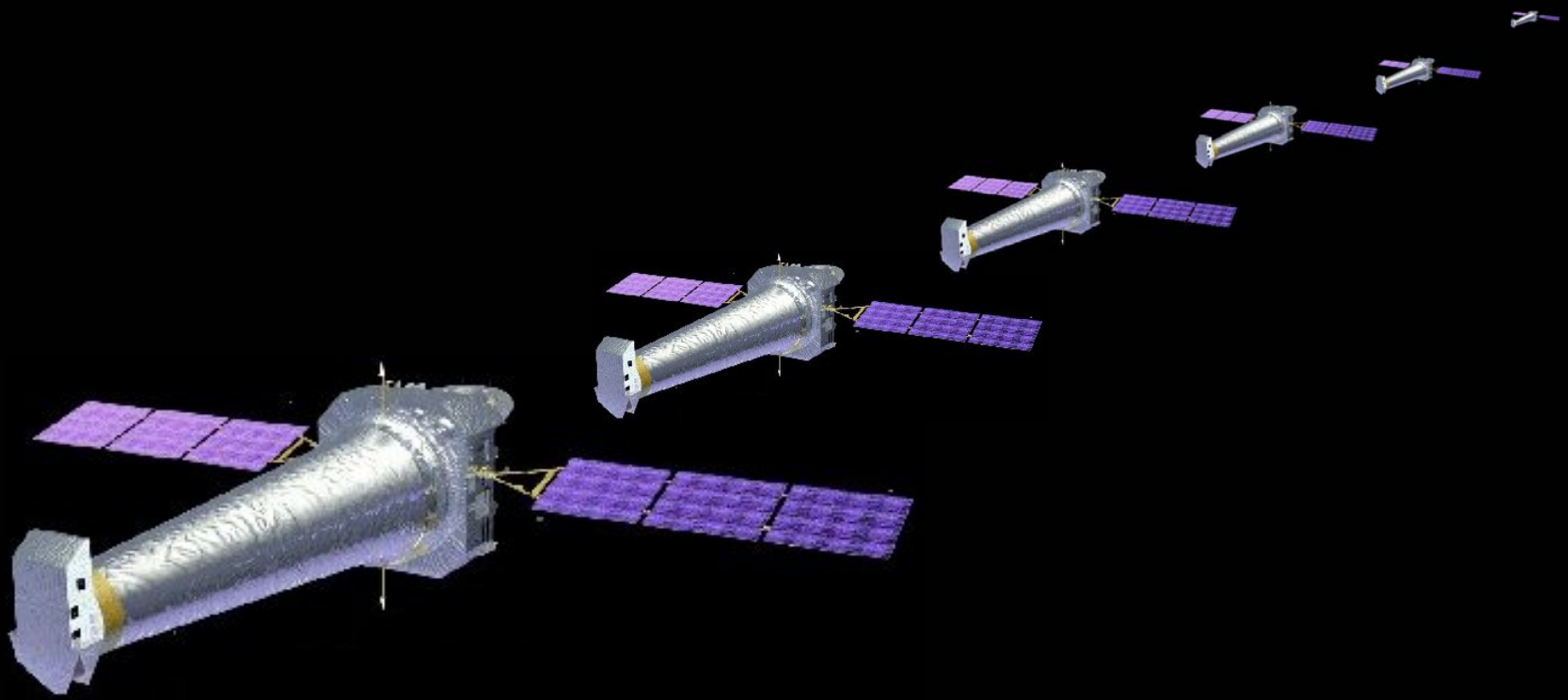
- Eccentricity: 0.57
- Inclination: 59 Degrees from Earth’s Equator
- Period: 63.5 Hours

SIZE MATTERS



- Larger satellites will appear brighter to the observer
- CXO might not show its largest side at the time

TOO DISTANT?



- How far is too far?
- 2x the distance = ¼ the light (dimmer by 1.5 magnitudes)
- The larger the distance, the more slowly the CXO will appear to move
- At 120,000km, the ISS would be no brighter than magnitude 12

YOU SAY YOU WANT A RESOLUTION?

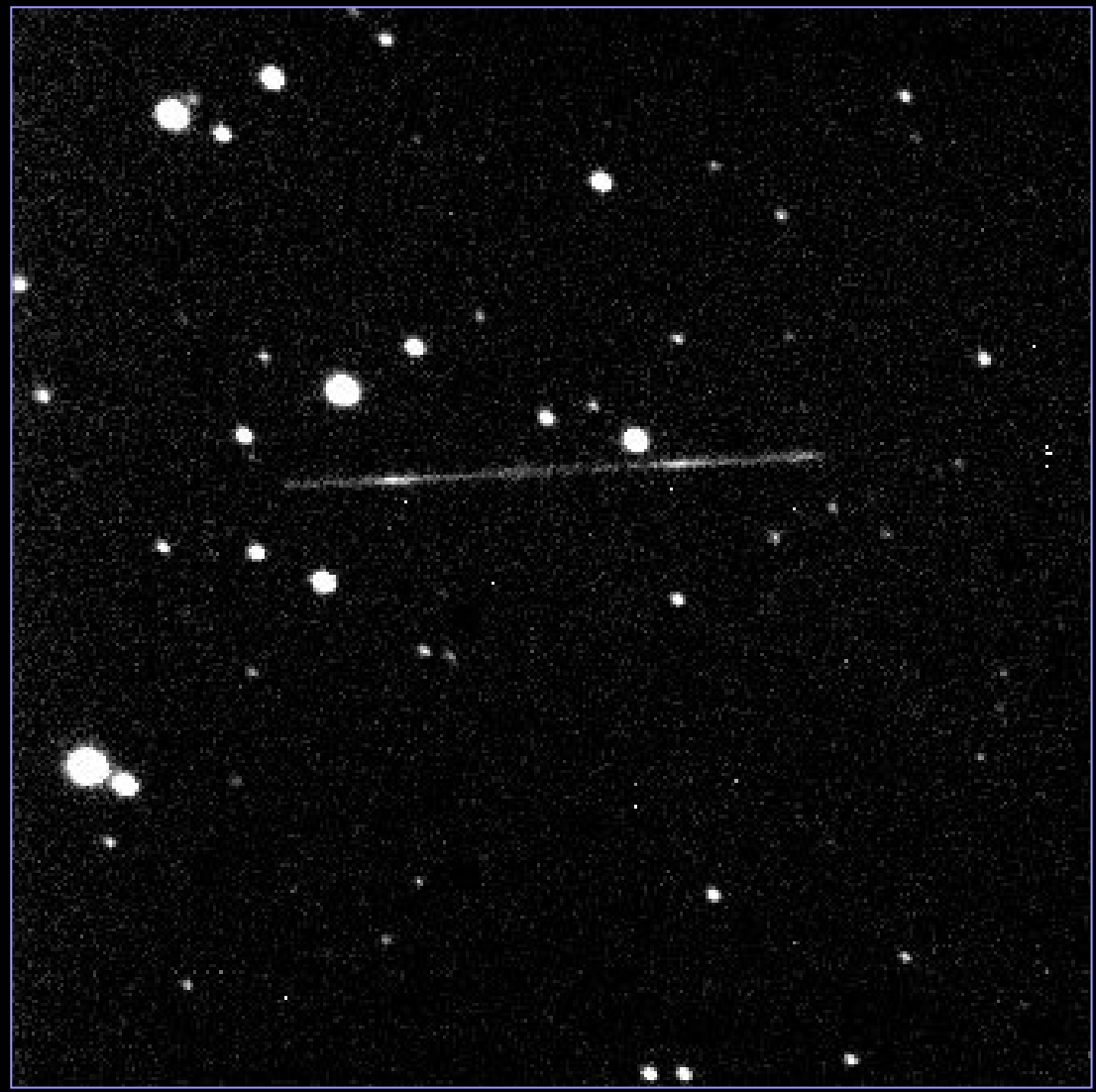
- At 29,000 km, the CXO would appear 0.14 arc-seconds in size
- i.e. a Toonie seen from a distance of 41 km

- At 120,000 km, the CXO would appear 0.03 arc-seconds in size
- i.e. a Toonie seen from a distance of 193 km

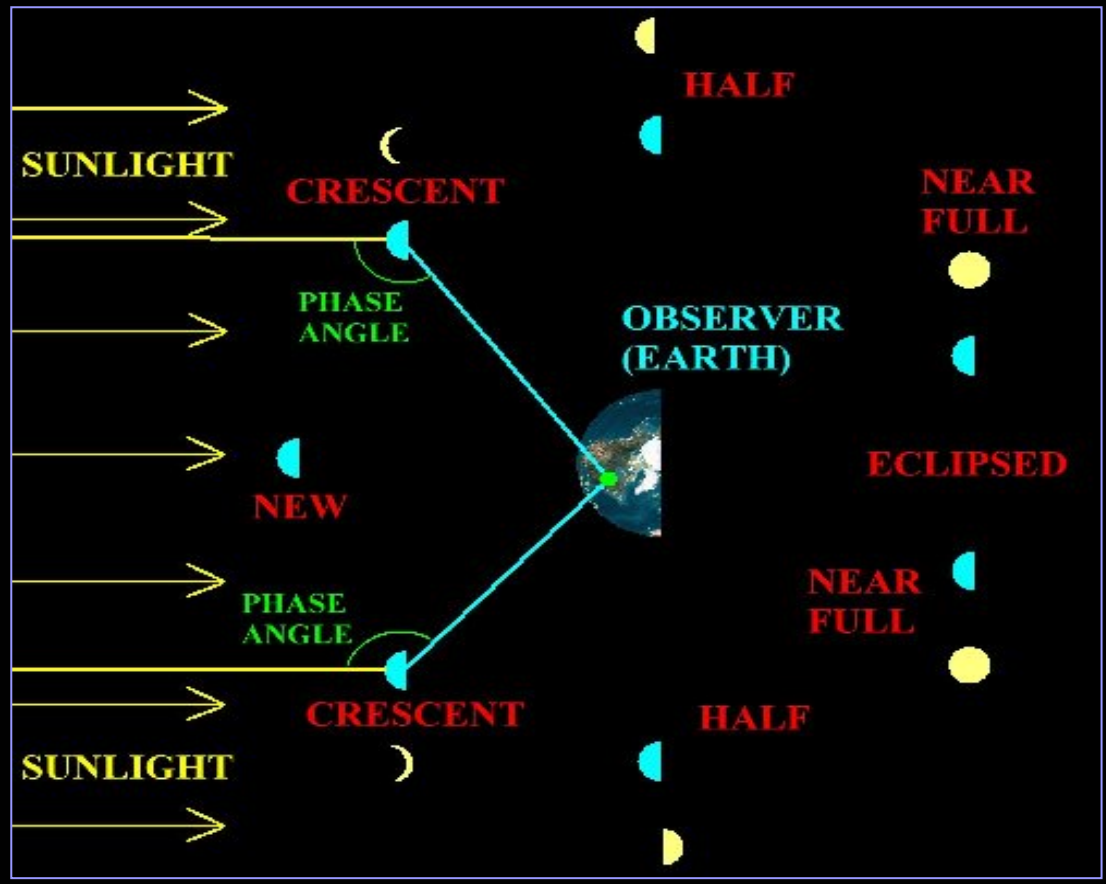
FOND REFLECTIONS ☺

- Percentage of sunlight reflected off CXO (albedo)
- CXO might not be very reflective (shiny or black?)
- Not a critical CXO design requirement

EXAMPLE OF VARIABLE REFLECTIVITY: A TUMBLING SL-6 ROCKET BODY

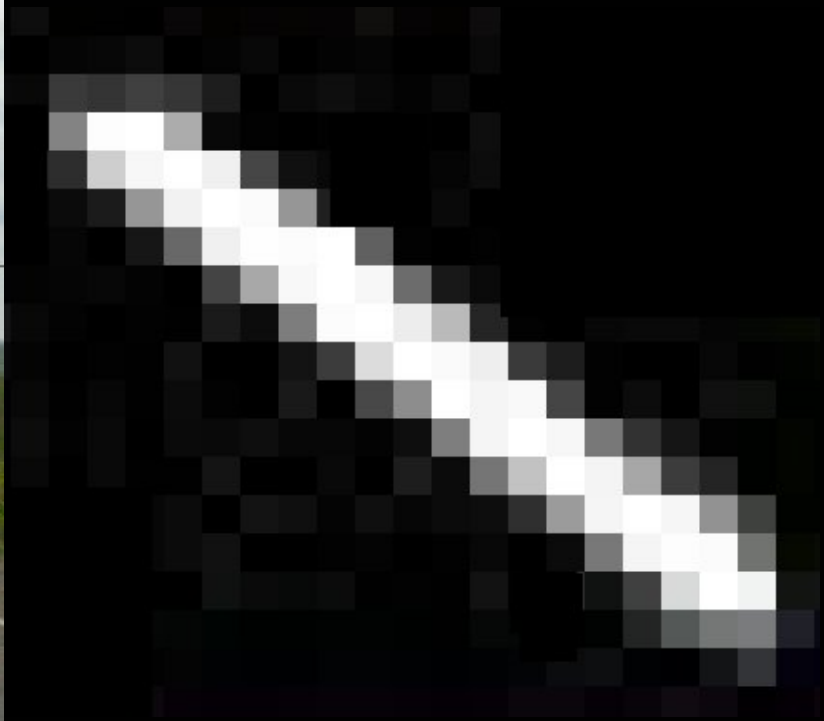


IT'S ONLY A PHASE



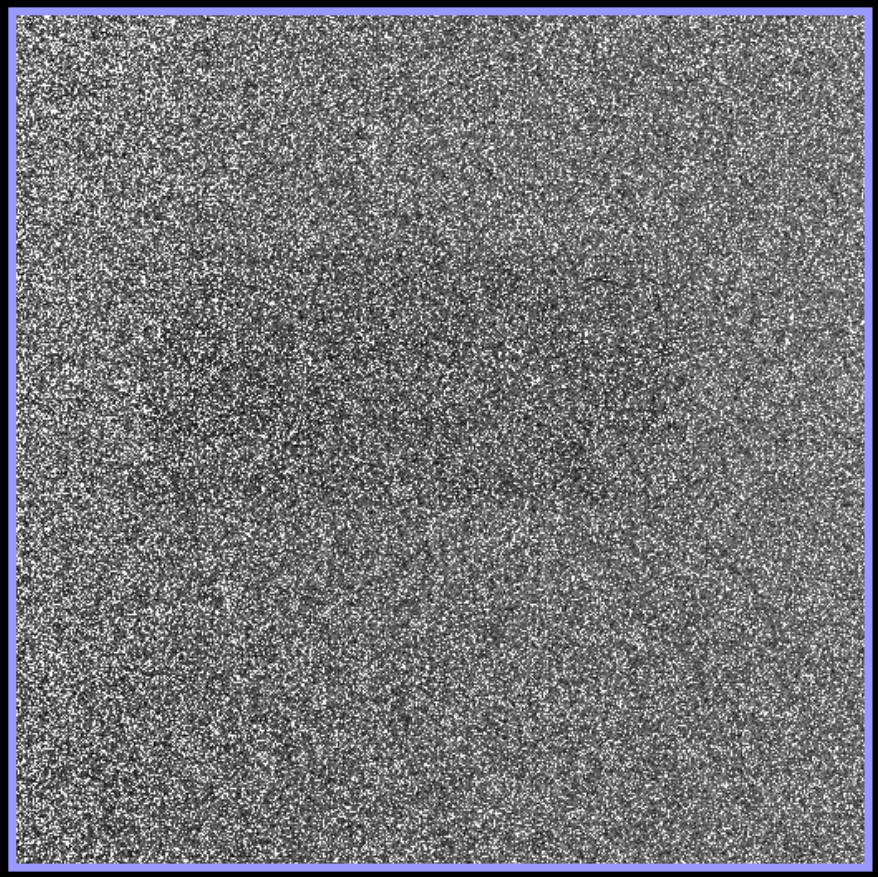
- Some percentage of the sunlit side will be seen
- Sometimes the phase will be undesirable
- Phase under 40% is considered dim (rule of thumb)
- CXO is not a sphere!
- Eclipse means little to no detected light

SPEED KILLS



- CXO’s light will move across the pixel array
- The faster the travel, the lower the exposure time per pixel
- If too fast, no detection (too low exposure time/pixel)
- If too slow, saturation (too much light for pixels to handle)

KEEP THAT NOISE DOWN!

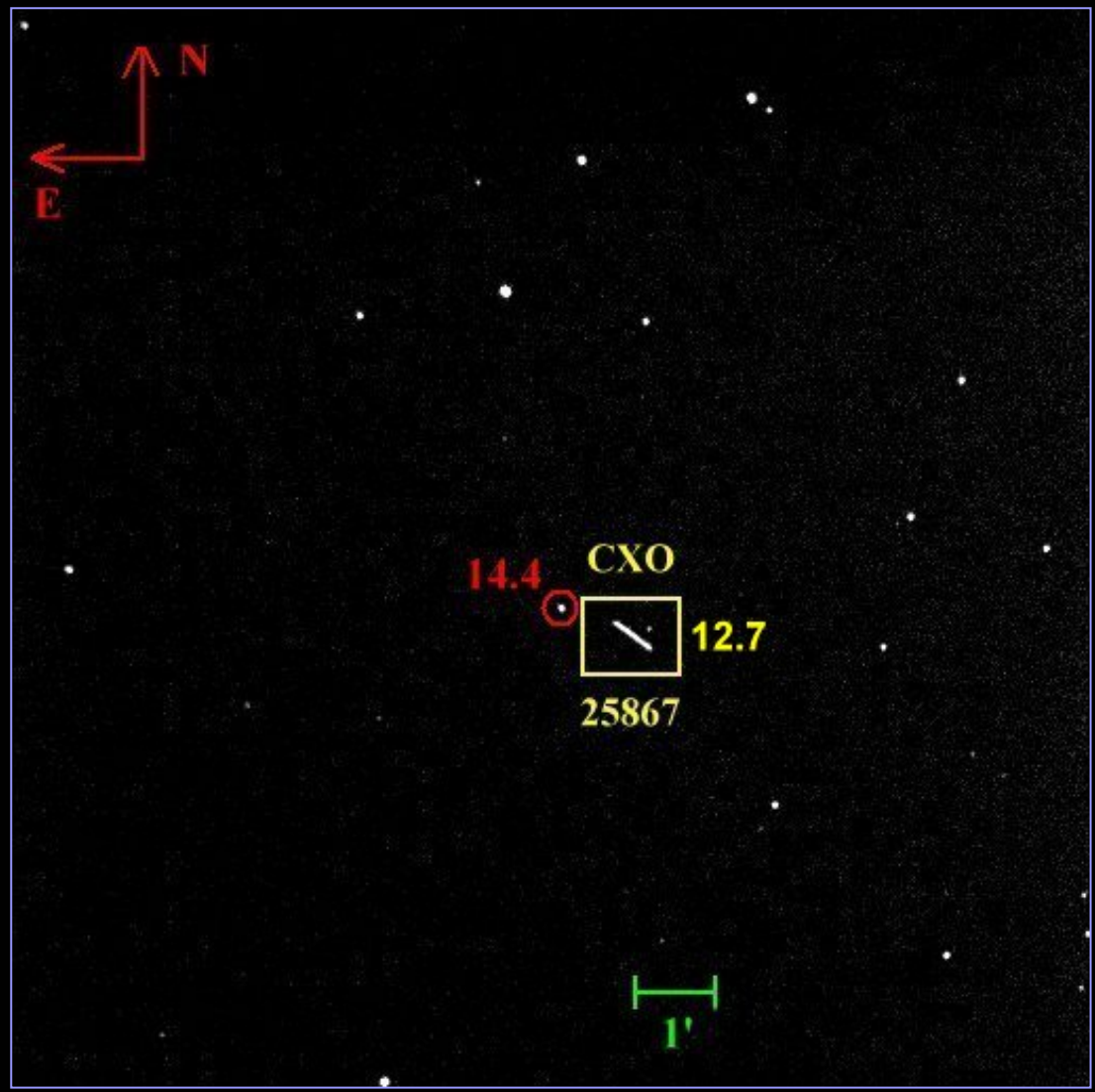


- CCDs suck up light from the sky too (light pollution)
- Lower exposure time = lower total sky noise
- CCDs need to be cooled to keep thermal noise down
- Light from satellite still might not be able to overcome the total noise

CHECKLIST FOR ATTEMPT #1

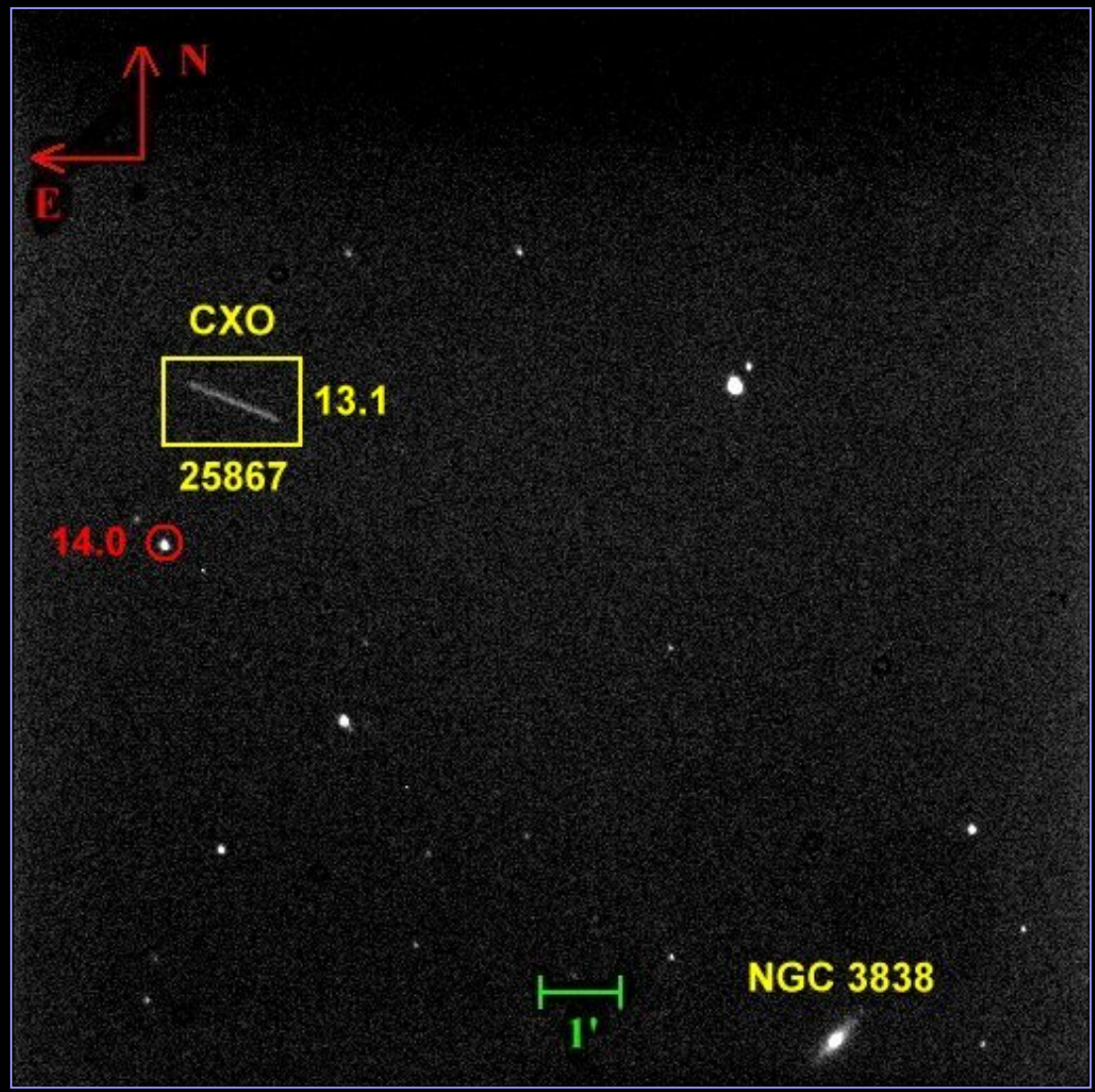
• CXO ORBIT ELEMENTS FILE	UPDATED
• CXO ORIENTATION	??????
• CXO RANGE	89,000 KM
• CXO REFLECTIVITY	??????
• CXO PHASE	65%
• CXO ANGULAR VELOCITY	3”.5/SEC (2.2 PIX/SEC)
• CCD CHIP TEMPERATURE	-40 DEGREES C
• EXPOSURE TIME SETTING	10 SECONDS
• MOON PHASE	FIRST CRESCENT (SET)
• TIME	07:02 U.T.C. 12/06/05
• COORDINATES (J2000.0)	R.A. = 10^h 53^m.7
	Dec. = +54^o 11’

ATTEMPT #1: DECEMBER 6, 2005



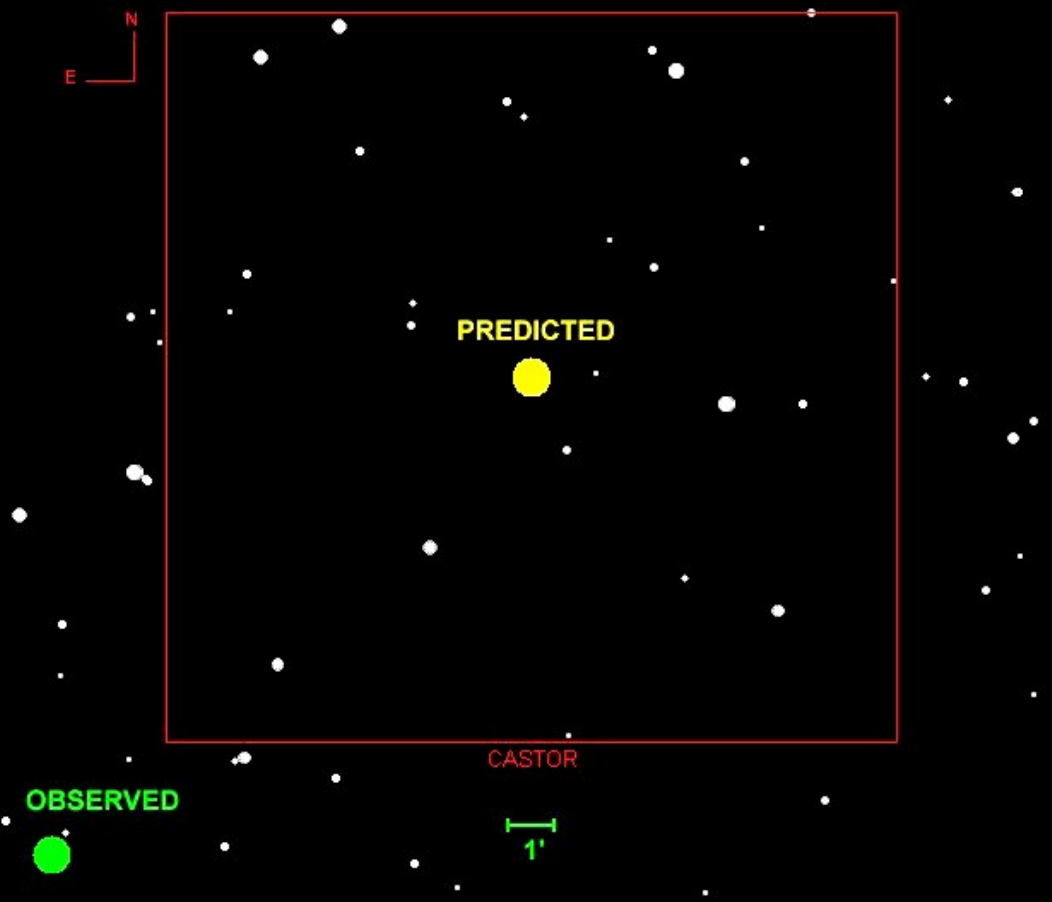
07:02:53 U.T.C. / 10 sec. / 89,000 km / 65% / -40C

ATTEMPT #2: FEBRUARY 13, 2006



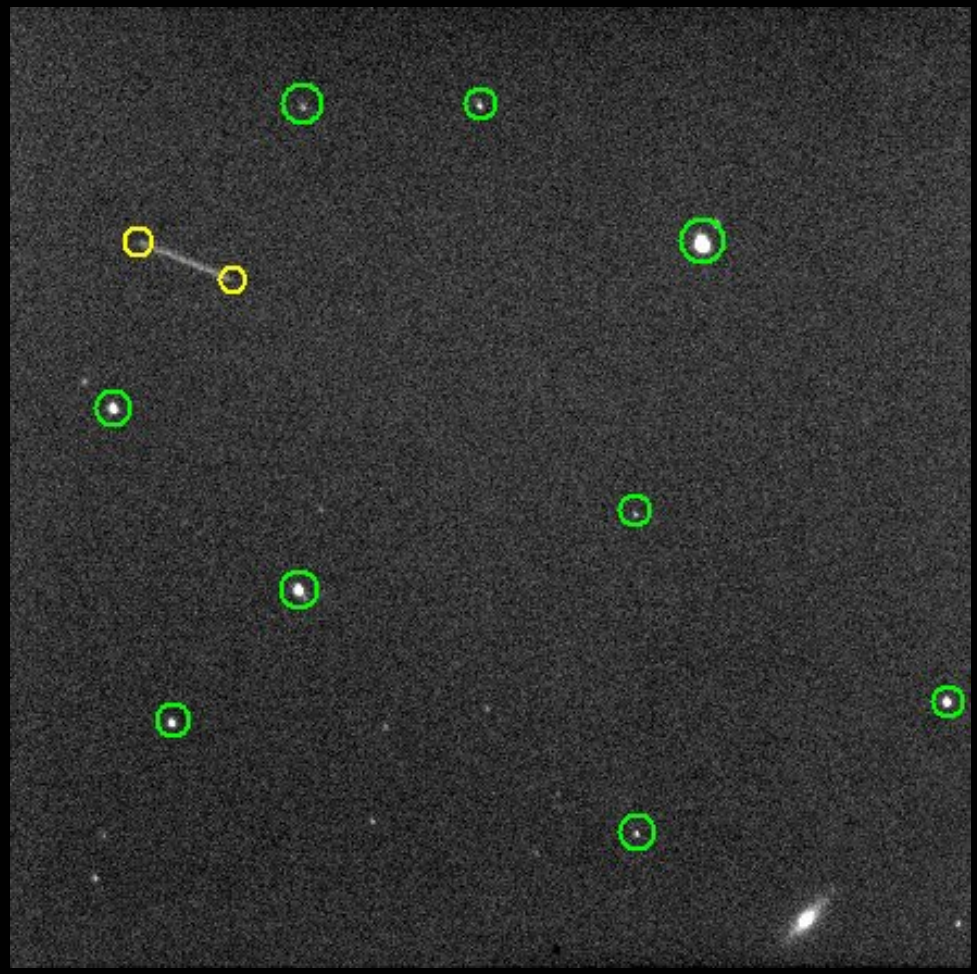
04:25:30 U.T.C. / 30 sec. / 101,000 km / 82% / -20C

WAS IT REALLY THE CXO?



- Few artificial satellites move so slowly
- Direction and orientation of the streaks were the same as predicted
- Rarely obtain two satellites in the same FOV
- Detected again with a similar error 2 months later

TRACKING THE CXO



- Timing was not the critical component in this case
- Astrometric accuracy was the most critical component here
- Tracking data could reduce the offset in the orbit elements
- 8 images taken over 25 minutes (before sky clouded over)

TRACKING THE CXO

Tracking Data: #25867 - Chandra X-Ray Observatory (CXO)

001	2006 044 04 25 30.670	11 45 07.820 +58 04 21.76
002	2006 044 04 26 00.670	11 45 16.020 +58 04 46.26
003	2006 044 04 46 55.670	11 51 10.990 +58 23 07.29
004	2006 044 04 47 15.670	11 51 17.410 +58 23 21.40
005	2006 044 04 47 35.067	11 51 22.160 +58 23 39.61
006	2006 044 04 47 55.670	11 51 28.390 +58 23 55.43
007	2006 044 04 48 15.670	11 51 34.190 +58 24 11.93
008	2006 044 04 48 35.670	11 51 38.850 +58 24 27.97
009	2006 044 04 48 55.670	11 51 45.190 +58 24 46.01
010	2006 044 04 49 15.670	11 51 50.020 +58 24 58.87
011	2006 044 04 49 25.670	11 51 53.650 +58 25 09.45
012	2006 044 04 49 45.670	11 51 58.690 +58 25 23.76
013	2006 044 04 49 55.670	11 52 01.920 +58 25 32.85
014	2006 044 04 50 15.670	11 52 07.150 +58 25 47.12
015	2006 044 04 50 30.670	11 52 11.740 +58 26 00.09
016	2006 044 04 50 50.670	11 52 16.770 +58 26 15.95

ASTRON SL-12 R/B: FEBRUARY 24, 2006

02:26:25 U.T.C. / 20 sec. / 124,000 km / 96% / -20C

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