

*Neolithic (stone
age) “records” of*

ASTRONOMICAL

TRANSIENTS ?



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Having modern instruments, why do we need ancient observations?

- The sky is constantly changing.
- Some change is (fairly) predictable – like planetary (and lunar) motion, eclipses
- Many transient events are not – comets, meteor(ite)s, novae, sunspots, aurorae...
- Even naked eye observations, if objective and reliably archived, are indispensable.
- No written record from Neolithic and before

Using written historical records, various studies have been pursued



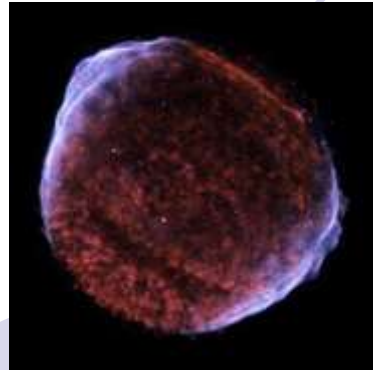
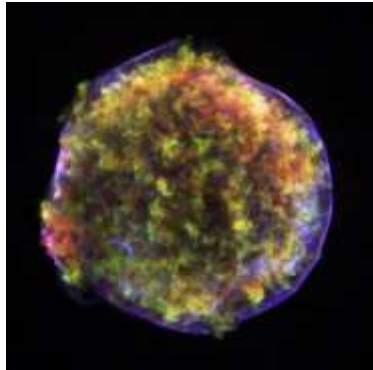
- Research on comets
- Supernovae associated with young remnants (age, light curve, etc.)
- Meteor showers
- Eclipses, rotation of the earth
- Sunspots, solar activity (including aurorae)



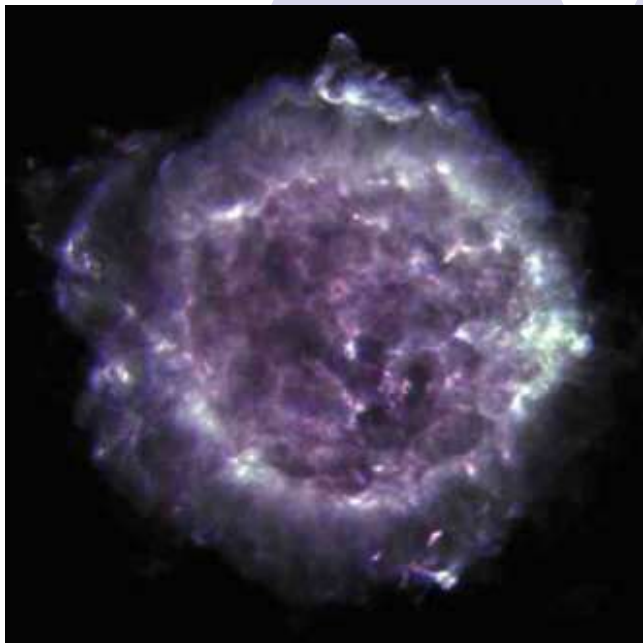
Let's consider several examples

- Halley's comet: bright, returns every ≈ 76 y
- Chinese records go back to 240 BCE
- Of 29 returns to 1910, 28 were observed in China: the record is 97% complete
- P/Halley is a naked-eye object for 1-2 mos each return: helps mitigate weather effect
- Nonetheless remarkable that so little information has been lost

Supernovae (SNe) & their remnants (SNRs)



- Consider SNe within 5 kpc
- Some 10 young SNRs are known, including: Tycho, Crab, etc.; & G292.0+1.8
- They have been linked to SNe in: 1604, 1572, 1181, 1054, 1006, 393, 386 & 185 CE
- Cas A & G292 missed
- SN record \approx 80% complete



How old is sky awareness in human development?

- Knowledge of seasons important to agrarian societies
- Even of significance for earlier hunter-gatherers (spiritual aspect also important?)
- We know that there was considerable astronomical knowledge in ancient Babylon, Egypt, India, China
- These later developments had their roots in prehistoric (Neolithic) society

Among Neolithic implements in China, there is a striking image



- It might be described as a rosette
- It is usually called an eight-pointed star: 八角星 (BJX)
- It has been discussed in Chinese research since 1960s

These objects have been found at 24 widespread sites in central China

- The objects date from the period 4000 - 8000 years BP (or 6000-2000 BCE)
- The Neolithic in China is reckoned to have lasted from 8000-2000 BCE
- They appear as decoration painted on pottery, or engraved on jade and copper
- There are also carved three-dimensional examples, a sort of gearwheel

Some examples of BJX



蝉墩-1



大墩子-1



大墩子-2



大汶口-1



大汶口-2



大汶口-3



大汶口-4



坟山堡-1



高庙-1



划城岗-1



黄鹁嘴-1



黄鹁嘴-2



黄鹁嘴-3



黄鹁嘴-4



黄鹁嘴-5



呈娘娘台-1



凌家滩-1



凌家滩-2



凌家滩-3



柳湾-1



柳湾-2



柳湾-3



柳湾-4



南台地-1



潘家塘-1



七道湾子-1



青墩-1



王冈-1



西夏侯-1



野店-1



郑家坳-1



朶马台-1

Pottery example from Dawenkou, Shandong



- Date: 3450±950 BCE
- Typical of use as a decorative symbol
- In center of BJX there can be square or circle
- Archaeologists argue BJX represented an astronomical object

Engraved jade from Anhui; Lingjiatan culture



- Date: 3450±150 BCE
- Probably ritualistic purpose – holes for sewing to clothing?
- Unearthed between jade case like a turtle shell
- Strongly suggests astrological link

Shang shamans practiced scapulimancy and plastromancy



- For prognostication
- A text would be inscribed on “oracle bones”; cracks from heating would then be interpreted
- Most date from 1300-1050 BCE, found near Anyang

Example of BJX on copper, ca. 2000 BCE, Hongshan; Inner Mongolia



Gearwheel, Hongshan Culture. From Inner Mongolia, ca. 4000-3000 BCE



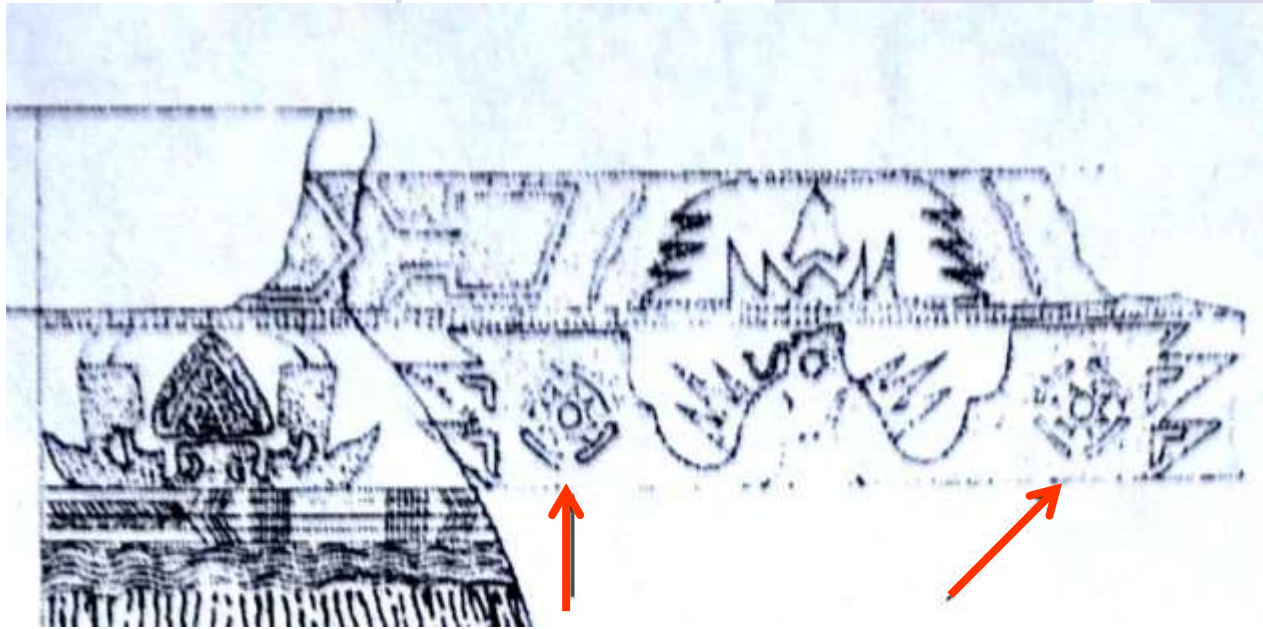
Stone spinning reel. From Kunshan, Jiangsu; Chuodun relic



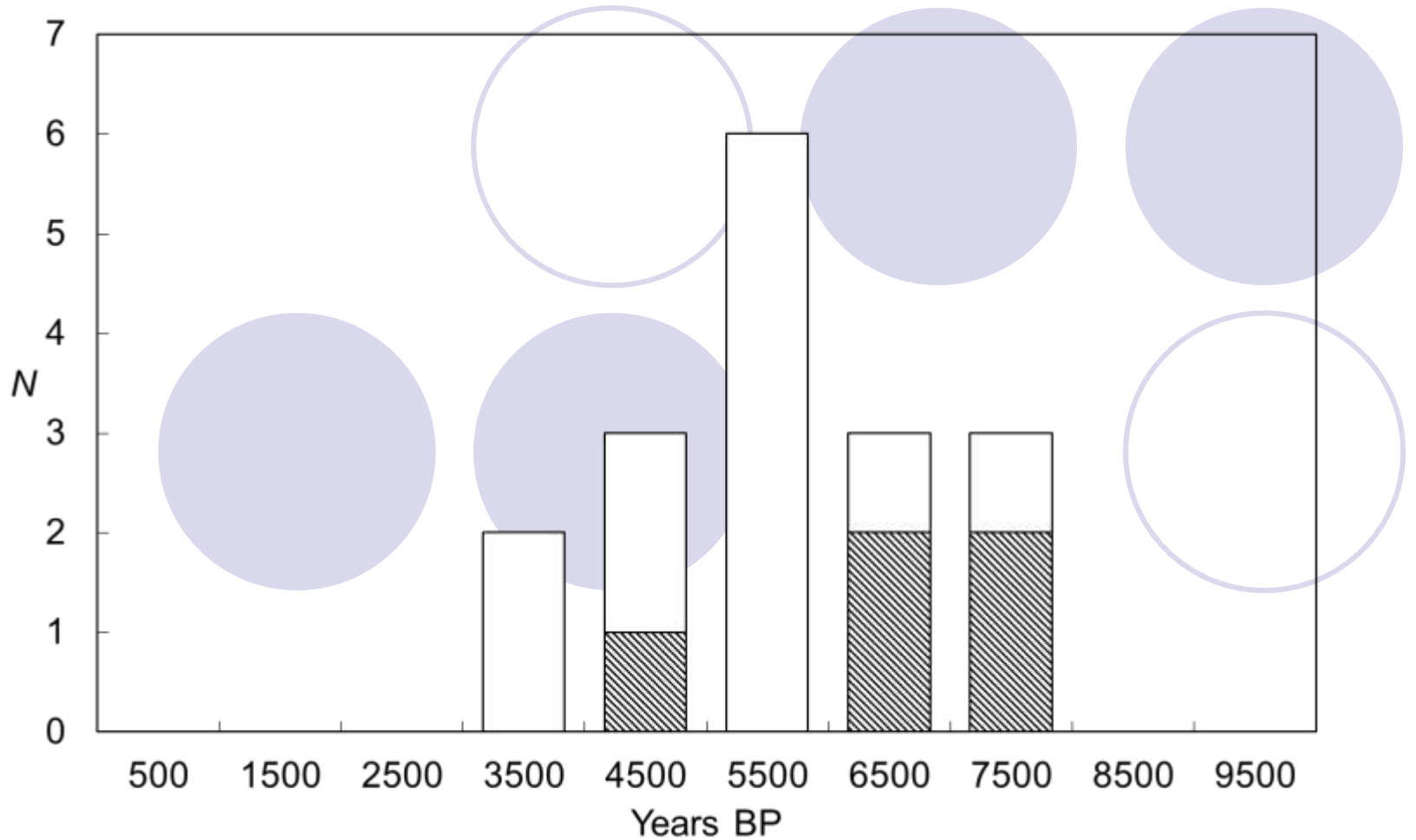
Even today we find BJX examples



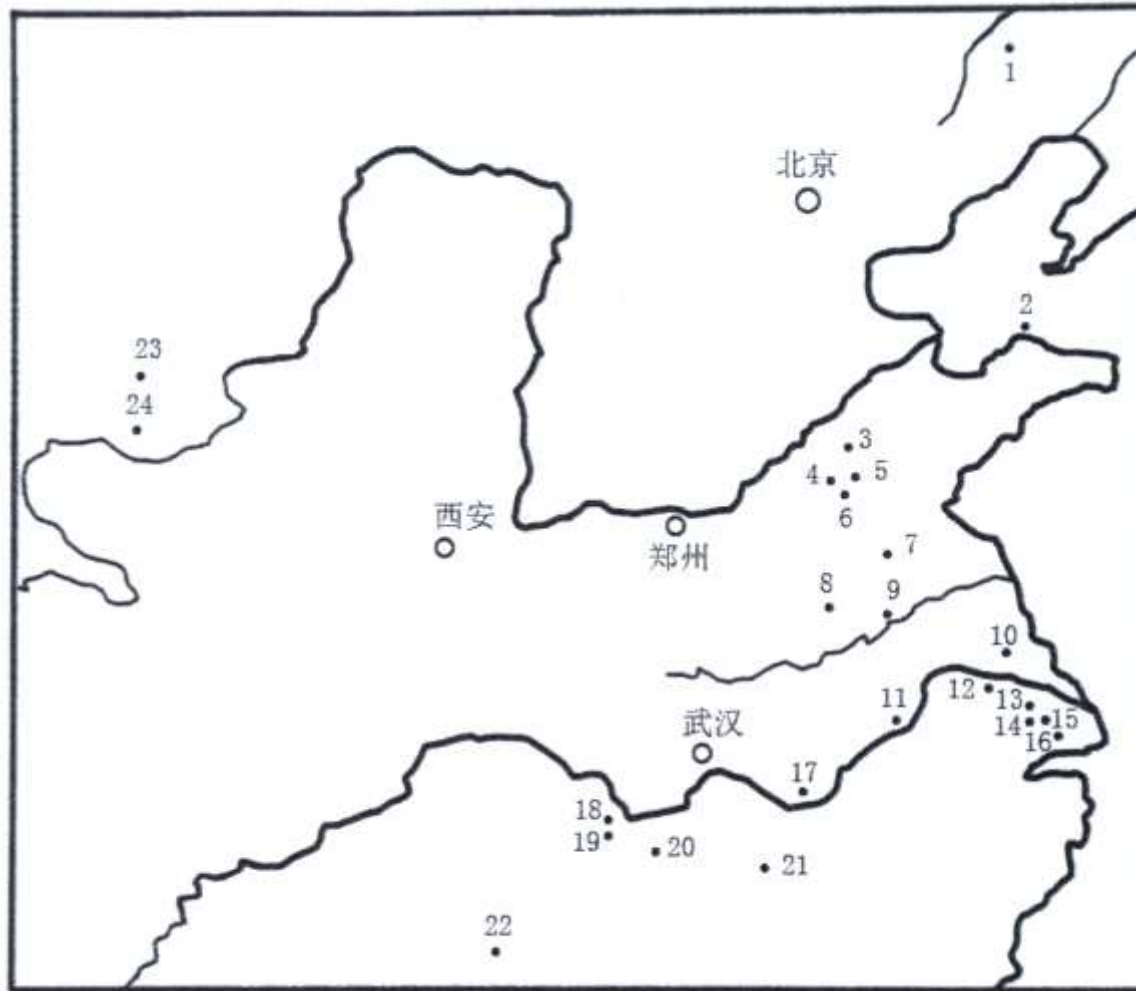
Oldest BJX found (Hongjiang City, Hunan) dates from 5800 BCE



Histogram showing dates of BJX finds (most accurate shaded)



Sites where BJX implements were unearthed: between the rivers



Yangshao culture pottery, Dahe village: sun motif (ca. 4000 BCE)



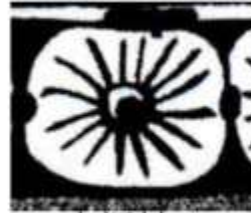
Neolithic representations of sun



大河村-1



大河村-2



大河村-3



大河村-4



划城岗-1



划城岗-2



跨湖桥-1



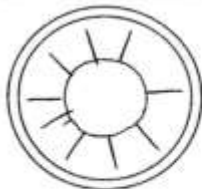
跨湖桥-2



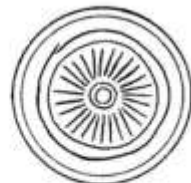
跨湖桥-3



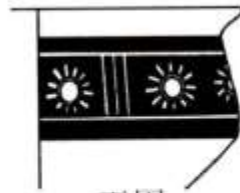
跨湖桥-4



双墩-1

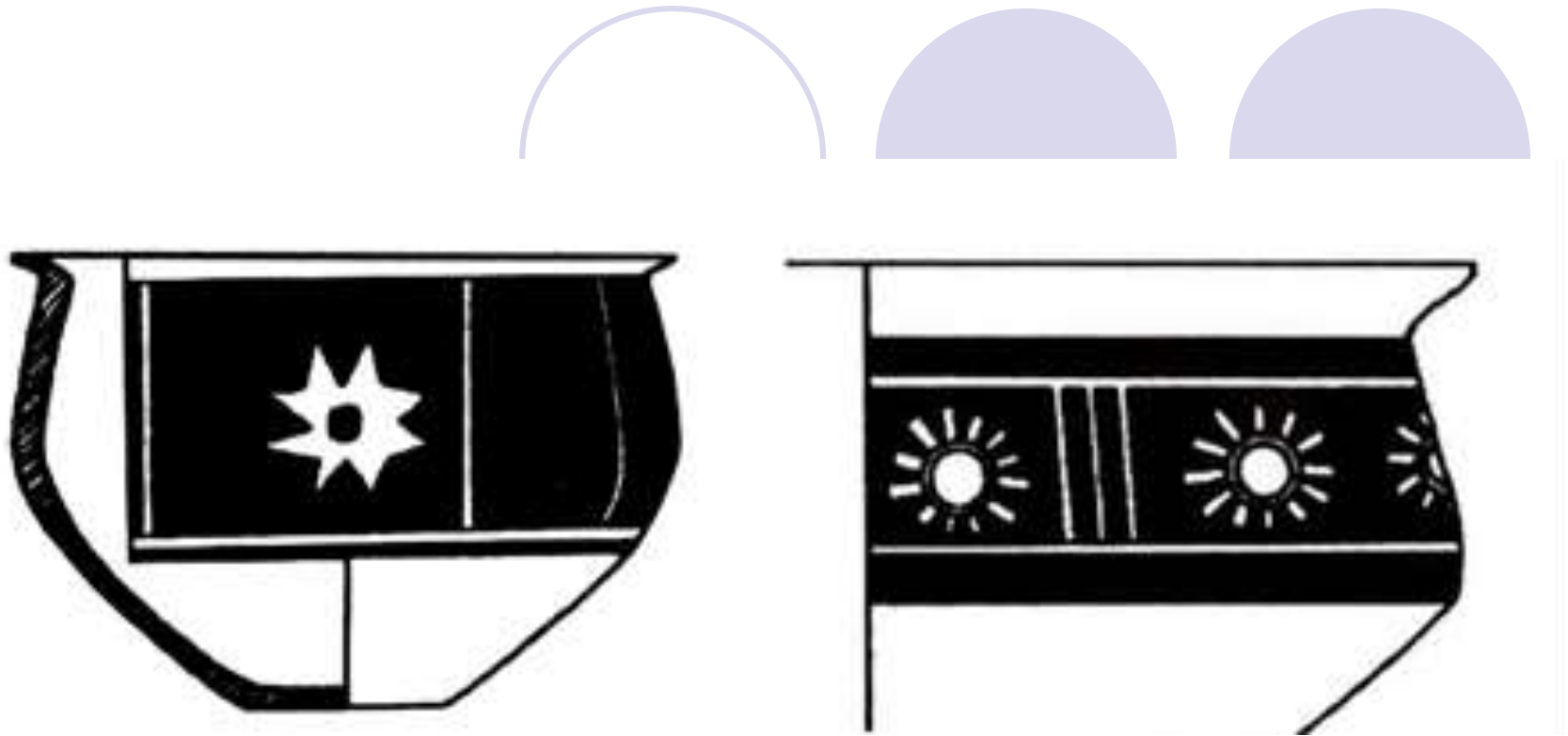


双墩-2

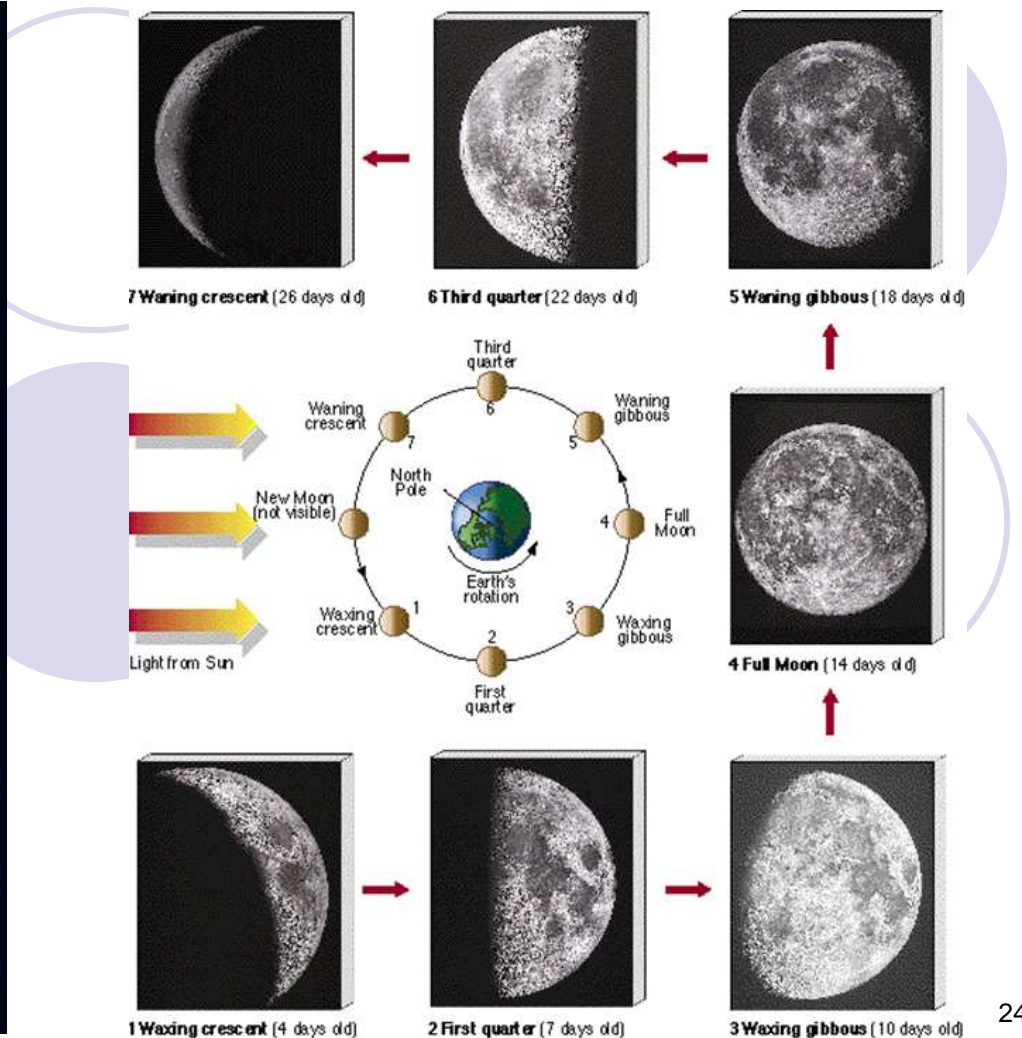


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BJX and solar images compared



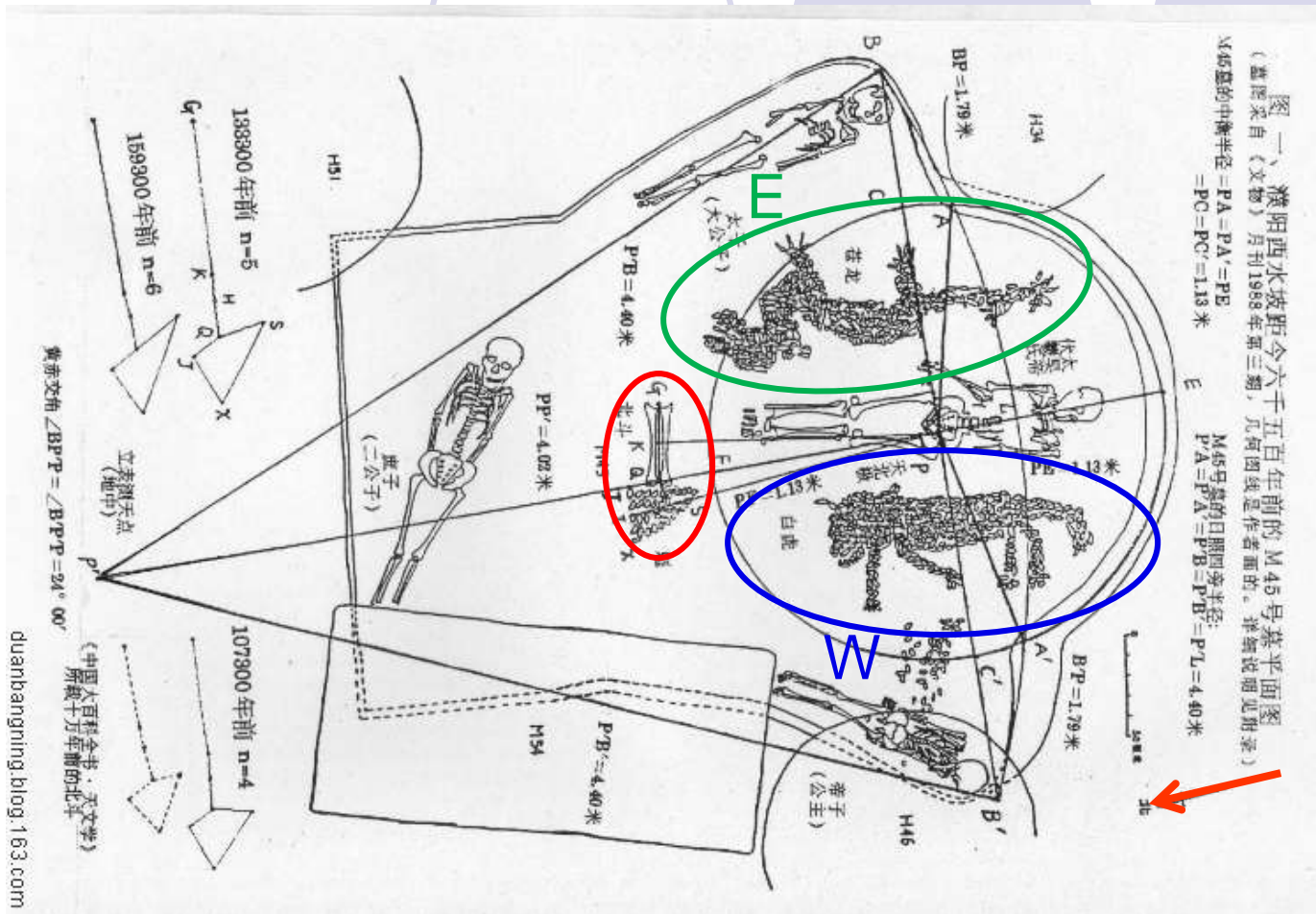
The sun clearly looked different. What about other bright objects?



Yangshao culture grave near Puyang ca. 3000 BCE: dragon & tiger



Green dragon (cang long) of east, white tiger (bai hu) of west & dipper: early constellations



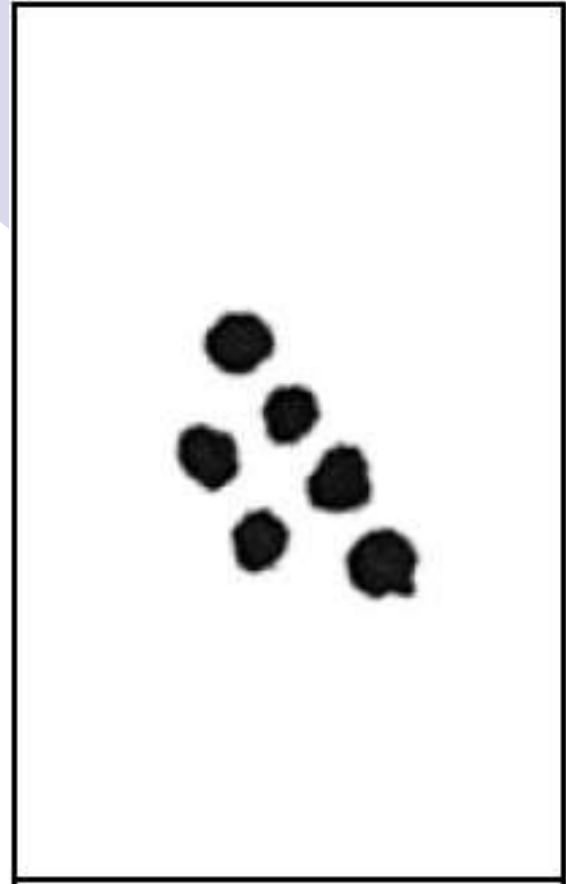
Lascaux cave in France: huge paintings of aurochs, from 15300 BCE



Largest aurochs image; what are
dots above shoulder?



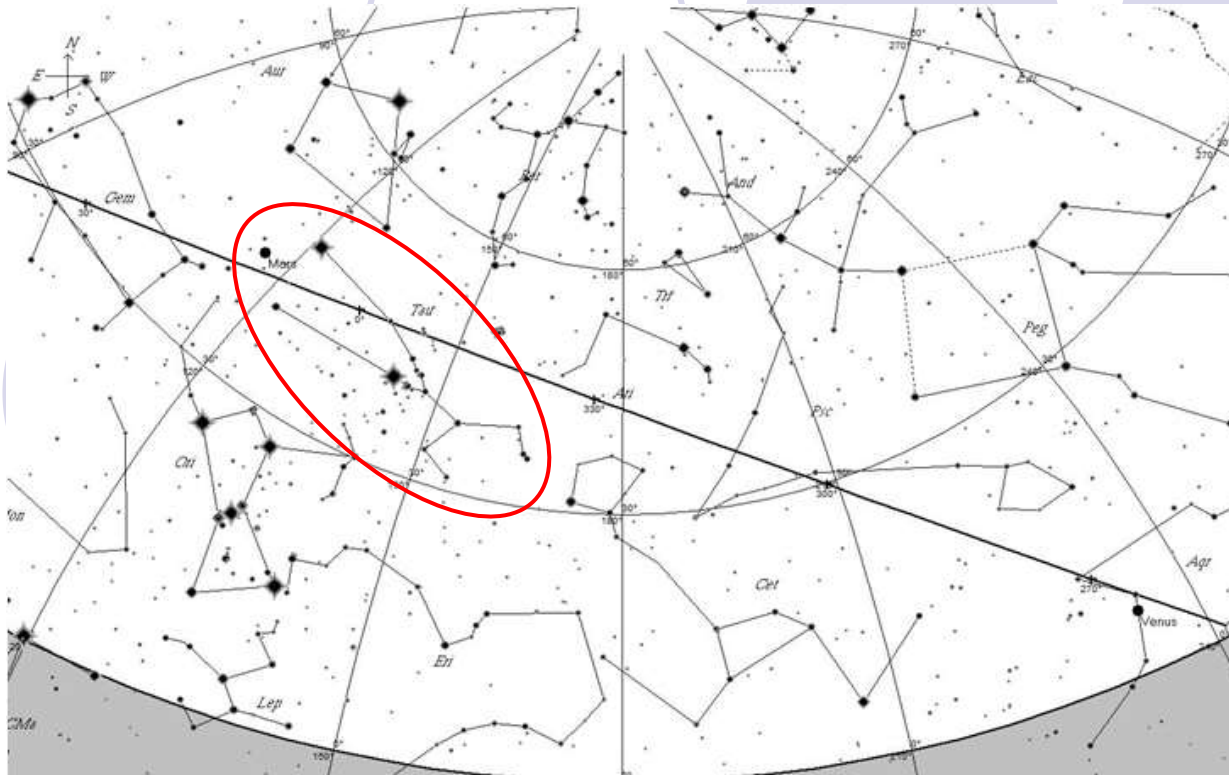
Do these six dots represent the Pleiades? Similar to Navajo image



And here, the Pleiades cluster



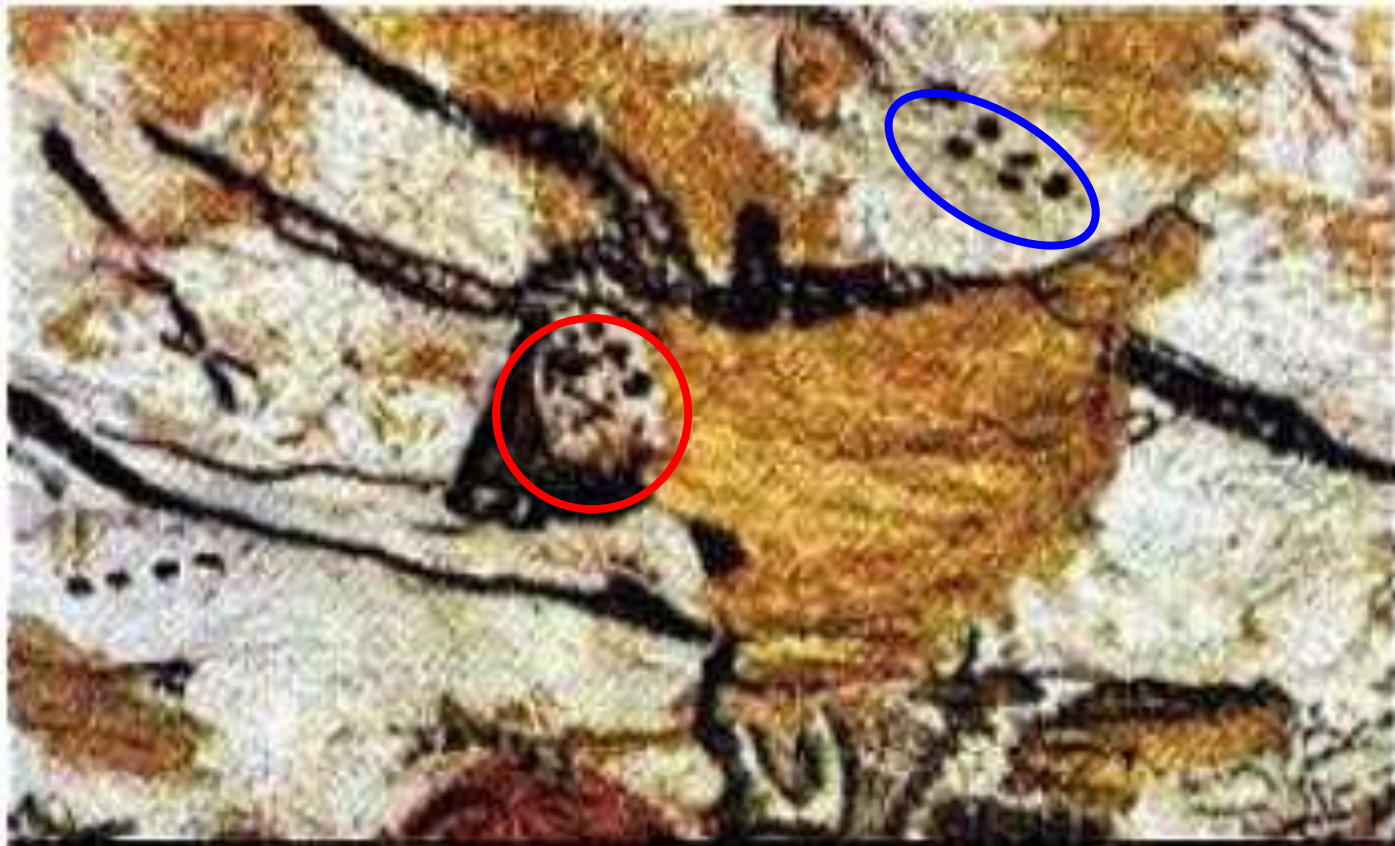
Constellations: shapes traced out by bright stars as in **Taurus**



Hyades, nearest open cluster, and **Aldebaran** (aurochs' eye)



So, idea is that aurochs is actually constellation Taurus & two clusters

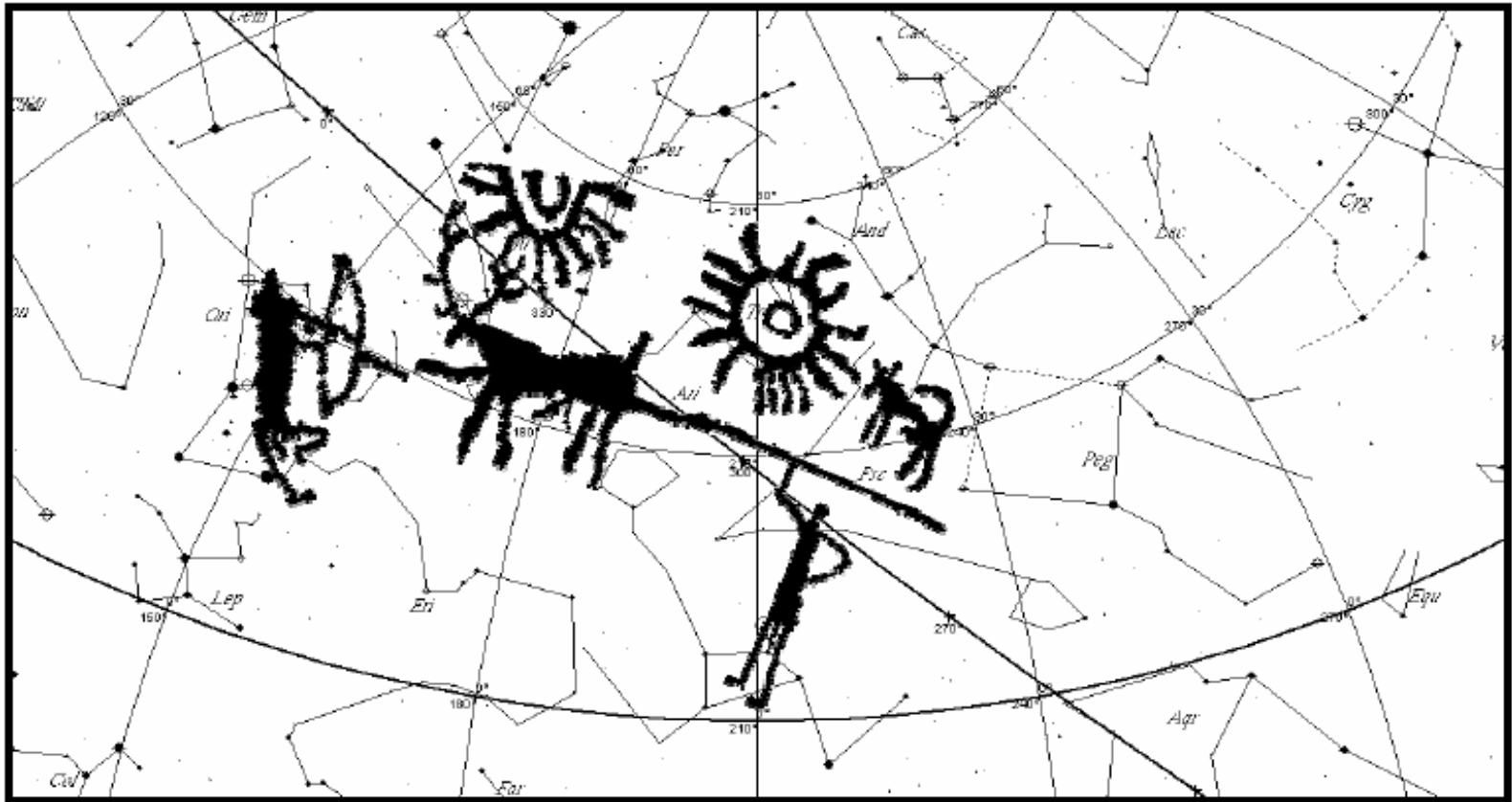


Younger and older examples from S. Asia

Neolithic rock carving (Kashmir, India): scene with 2 bright "stars"



Joglekar et al. (2006) argue that hunting scene is actually sky map



Hunter = Orion, stag = Taurus, star = HB9 SN₃₅

Older: cave art, Sulawesi > 44,000 yr, earliest "narrative" depiction



Let's return to the more recent 八角星

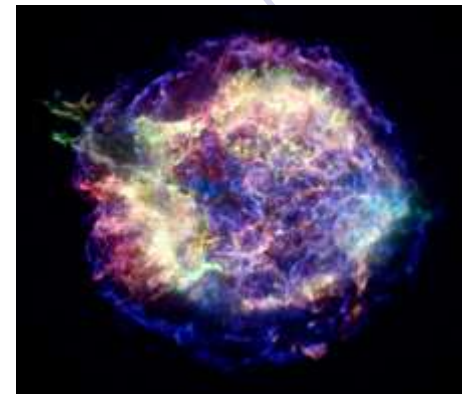
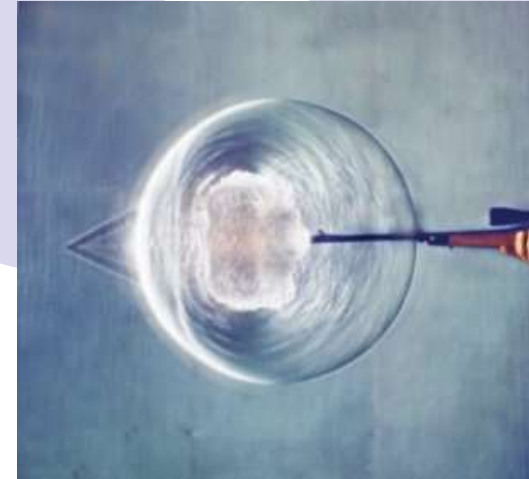
Is BJX really astronomical? Only one is associated with a naturalistic object

- That is a bird, and birds fly – they are seen in the sky
- Rather like the association of sun with a bird, which carries sun across the sky
- Strengthens connection with astronomical object
- Bird is eagle, daytime bird of prey. Was BJX star also visible in daylight?



We suggest that BJX was a bright, nearby supernova

- How to search for candidates?
- Supernova blast produces shocks
- Shocks heat gas and accelerate fast electrons
- Supernova remnant: strong X-ray & radio emission



All candidates already known

- Nearby remnants fairly easy to observe (little absorption by interstellar medium)
- Remnants ≈ 8000 yr old are strong X-ray and radio emitters
- Such objects are found in catalogues, which we expect to be quite complete for nearby remnants
- In our search we have located eight candidates

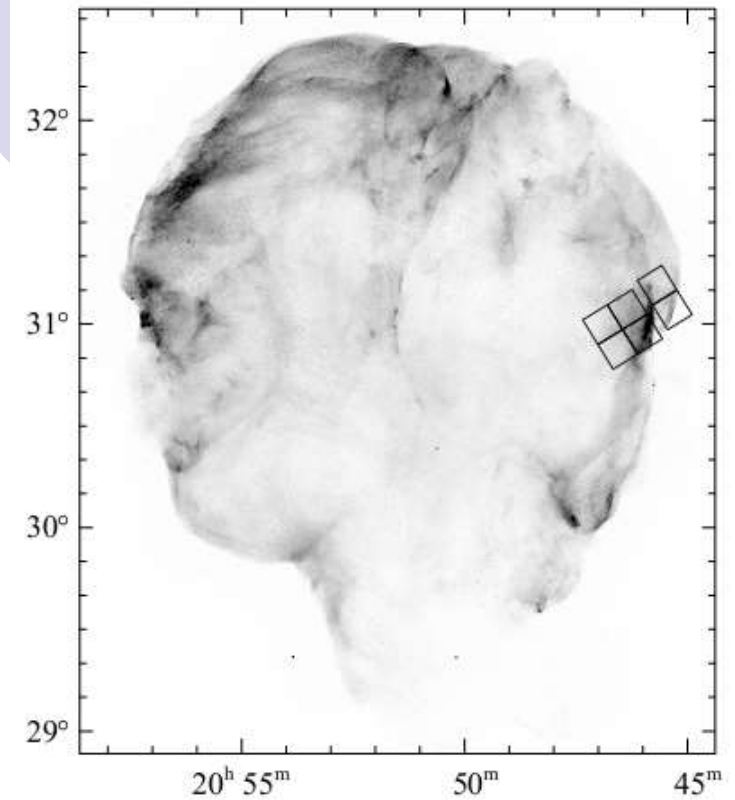
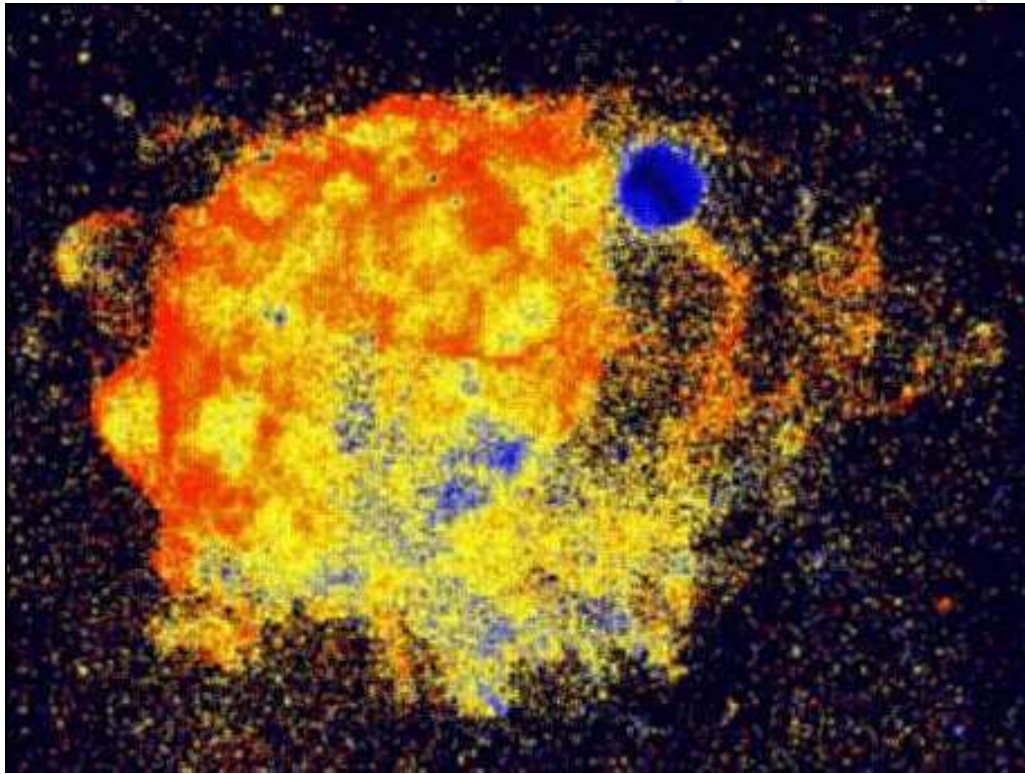
How do we determine age and distance?

- Age can be estimated from the kinematics of the expanding remnant shell...
- Or (if there is an associated pulsar-neutron star) from the spin and rate of slow down
- Distance to some remnants can be determined kinematically...
- Or from pulsar distance...
- Or using stars in the same direction

Two candidates are particularly notable

- The Cygnus Loop is a large remnant some 440 pc distant; its age may be $\approx 20,000$ yr
- The Vela remnant is even closer (250-300 pc); the spindown age of its pulsar is 11,000 yr

X-ray images of Vela and the Cygnus Loop

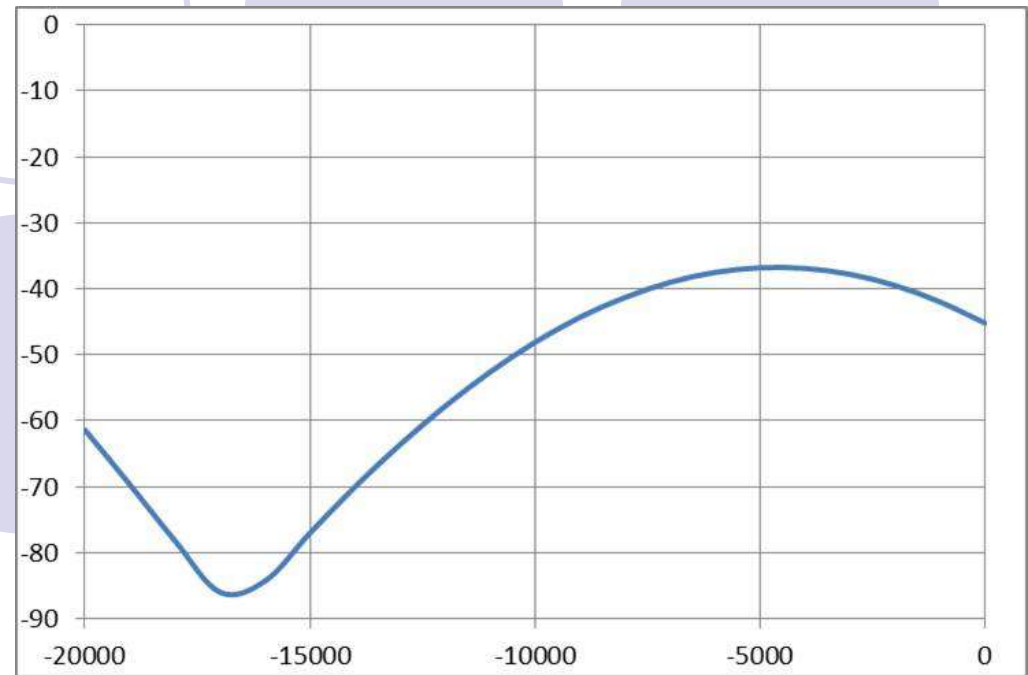


Distance, age of candidates; and effect of precession on declination

- The Cygnus Loop is a large remnant some 440 pc distant; its age may be $\approx 20,000$ yr
- The Vela remnant is even closer (250-300 pc); the spindown age of its pulsar is 11,000 yr
- Because of precession, the declinations of these sources may have been different 8000 years ago. In the case of the Cygnus Loop the change has been small

The Vela remnant has a low declination: it is a southern object

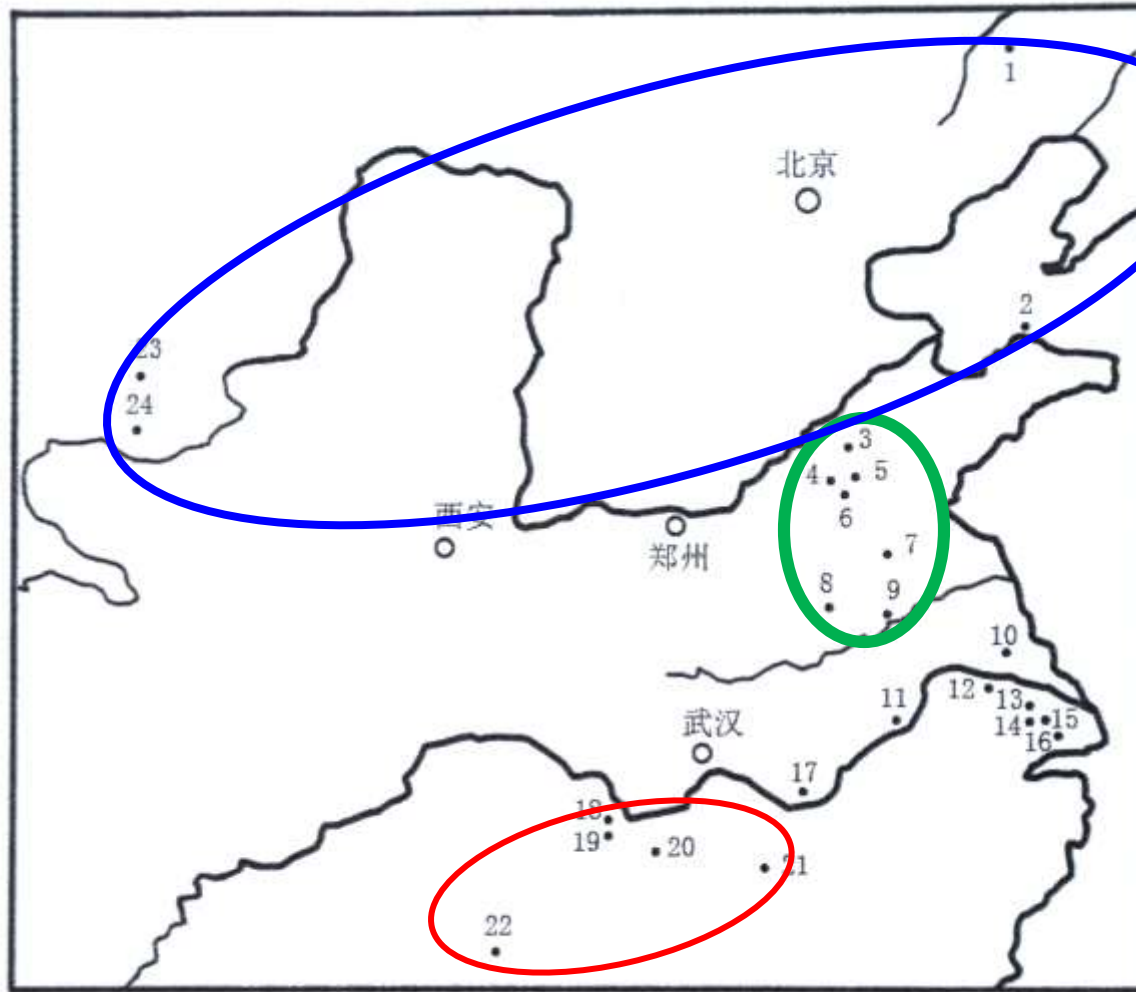
- Its declination has changed little over the past 8000 years
- It would therefore have been visible at all the BJX sites
- Before 10,000 years ago, however, Vela would have been far south



There is a striking, but peculiar pattern in the BJX locations

- The oldest relics – <6700> yr – are found in the southernmost locations.
- Going further north, the archaeological BJX artefacts tend to be younger: <5800> to <4400> yr for the most northerly.
- Maybe the star pattern originated in the south, the design then spread north.
- It is also possible that the supernova could only be seen from the south...

BJX relics' age from south to north:
<6700>, <5800> & <4400> yr



Optical H α + [OIII] image of Vela



The supernovae from both sources would have been extremely bright

- The Cygnus Loop SN would have had a peak brightness ≈ -12
- For Vela it would have been ≈ -13 , brighter than the full moon
- They would have been prominent daytime objects for many weeks...
- And nighttime stars for years
- Could this have inspired the 8-pointed star?

We think that Vela is the more likely candidate

- It was probably brighter
- The age estimate is nearer to 8000 years
- There is a suggestion that an aboriginal stone carving in Australia may also depict the Vela SN outburst
- Little can be said about age of this cave image



Concluding remarks

- Star points – what eye sees in bright object
- Evidence for BIX being object in sky:
 - * Connection with astrology
 - * Carried by bird
- Bird of prey suggests daytime star
- Why 8 points? Unclear (but 8 is lucky number in China today).
- Can extract astronomical information from Neolithic images (but not unambiguously)

The End

Thank you ~ 谢谢