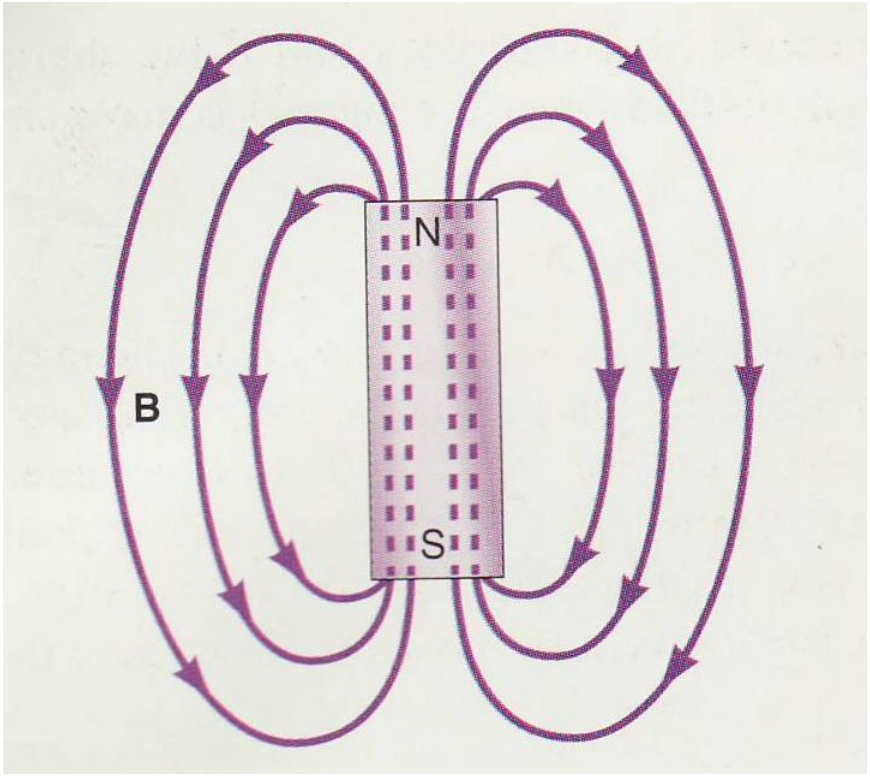
Magnetism



•Like electricity, magnetism can both attract and repel.

•Unlike electricity individual magnetic “monopoles” are not known to exist. But in electricity positive charge or negative charge can exist in isolation.

•Magnetic “field lines” much like with electricity, these emerge from a north pole and enter the south pole of a magnet.

Ok, has anyone in this room ever made a compass from scratch?

Here is the most amazing fact about magnetism

Magnetic fields exert a force on charged particles. Bizarrely, the force is proportional to the SPEED motion of the charged particle. Faster motion equals a larger force. It's Bizarre.

$$F_B = qvB\sin\theta$$

Even more odd, we have built into our physical body, (in our right hand) an arrangement that shows the relationship between the magnetic field the motion of the charged particle and the force experienced by the charged particle.

$$If\ \ the\ \ motion\ \ is\ \perp$$

$$to\ \ the\ \ B\ \ field\ ,$$

$$F_B = qvB$$

In what simpler units should magnetic field strength be measured?
The unit for magnetic field strength is the Tesla.

- Right hand rule #1.
- using the right hand hold the fingers together and thunb out “hitchhiking” at a right angle.

Fingers –	magnetic field lines
Thumb-	motion -charged particle
“palm push” –	force on a + charge
“backhand slap”-	force on a – charge

- Lets derive a formula for magnetic force on a current carrying wire in a magnetic field.

$$F_B = qvB\sin\theta$$

Individual electrons in the wire drift some length l in some time t

$$v_d = \frac{l}{\Delta t}$$

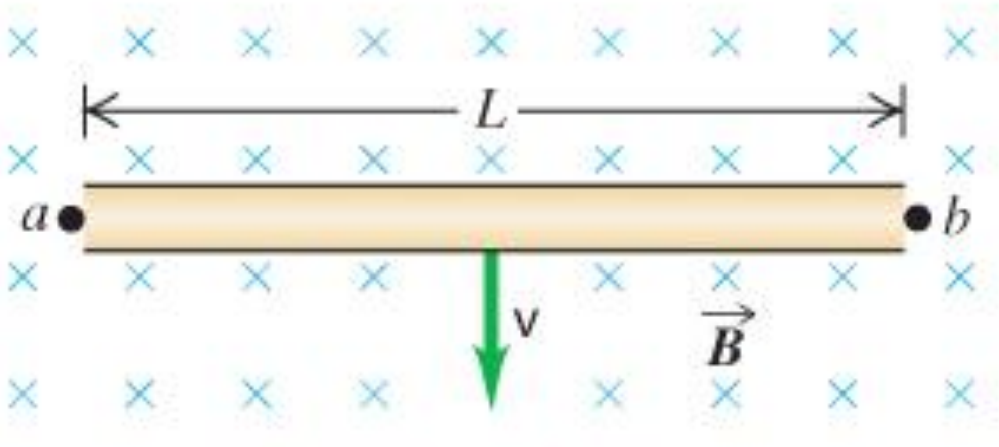
It should be pretty obvious what happens next . . . . .

$$F_{wire} = q\frac{l}{\Delta t}B\sin\theta$$

$$F_{wire} = \frac{q}{\Delta t}lB\sin\theta$$

$$F_{wire} = IlB\sin\theta$$

Something about “Motional EMF” and the induced E field.



Using our knowledge of the right hand rule consider the situation shown above. A magnetic field is oriented as indicated. A conductive rod is moved through the field perpendicular to the field lines as shown. One end of the bar develops a positive electric potential and the other a negative potential. Which end is positive?

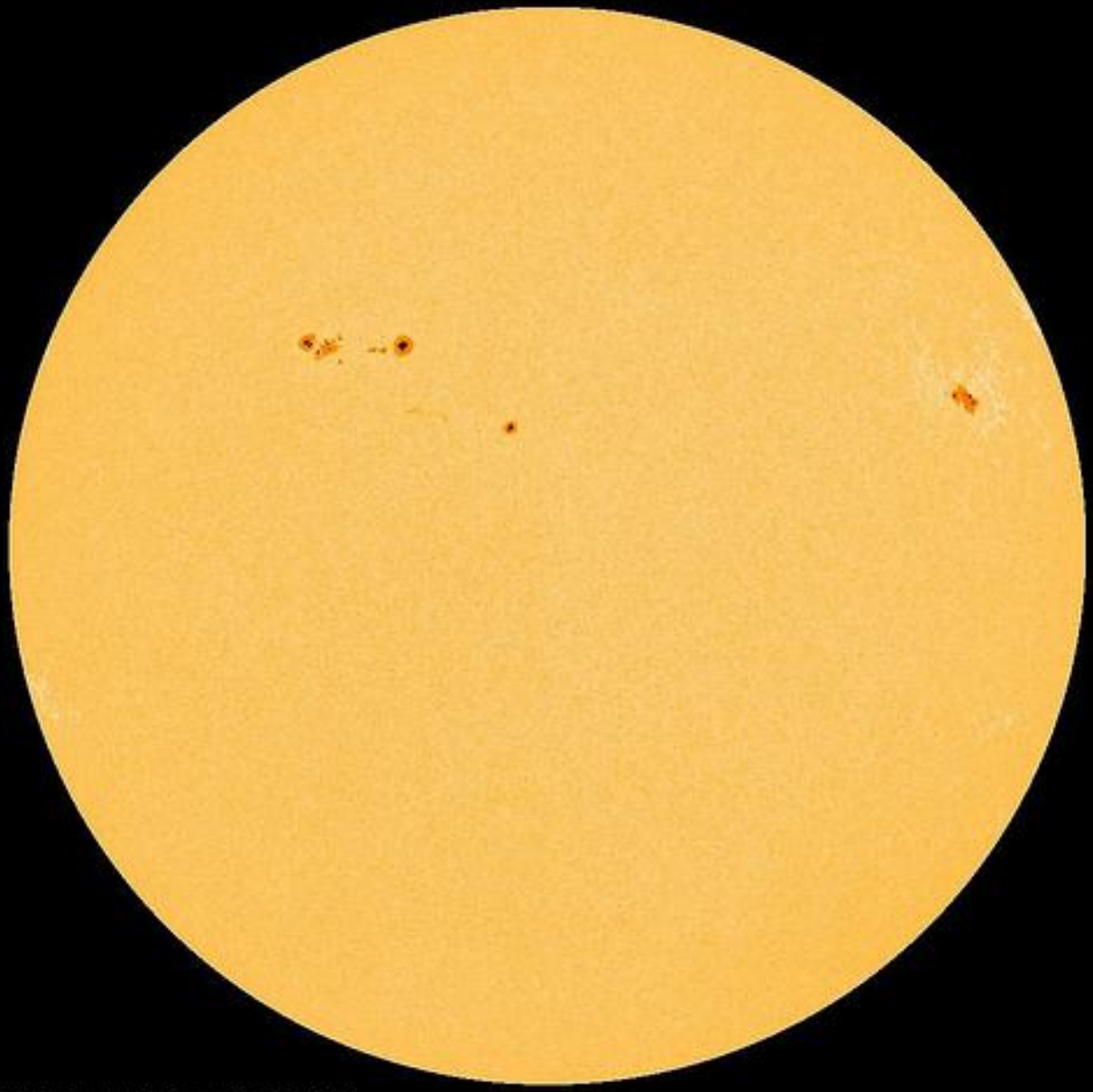
What is the orientation of the induced E field within the conductive rod?

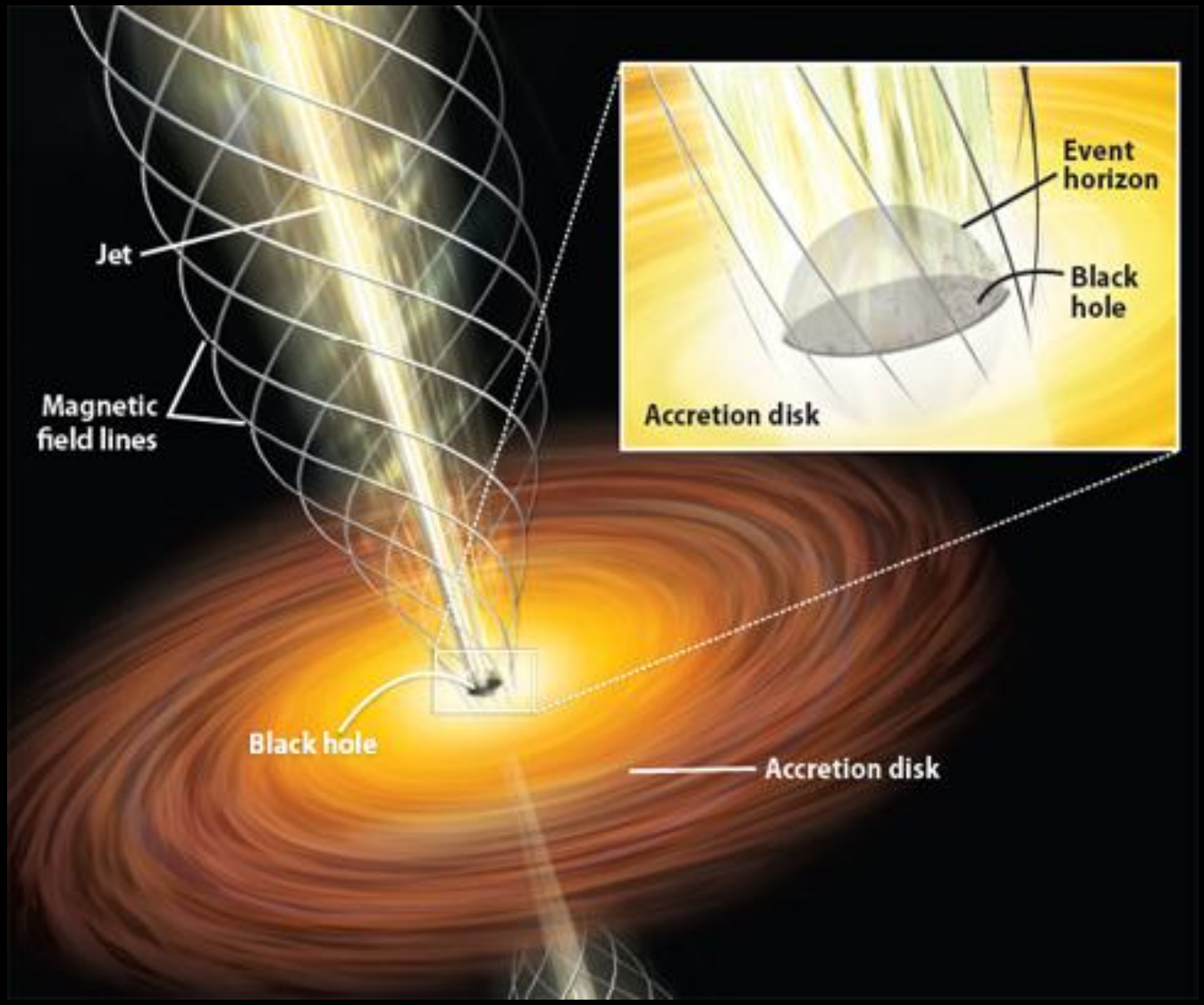
- Some quick thoughts about magnetic fields in nature:
- sunspots
- beams from pulsars, white dwarfs, and accretion disks around black holes,
- beams from active galaxies.

Can a person make their living studying sunspots?

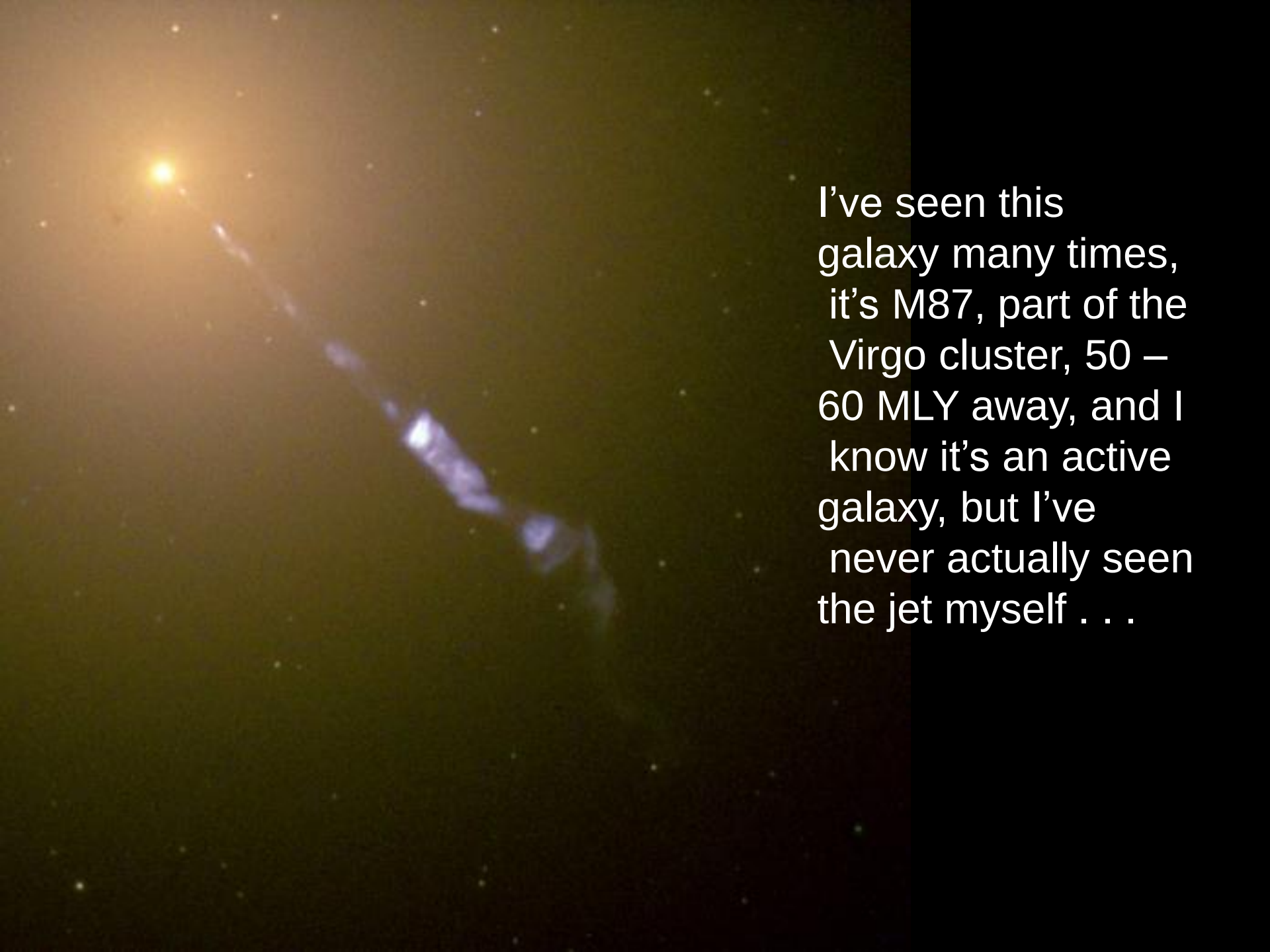
What are sunspots?

What economic impact do sunspots have?




Jet
Magnetic field lines
Black hole
Accretion disk
Event horizon
Black hole
Accretion disk

Centaurus A is an active galaxy about 13 million light years away, just next door.

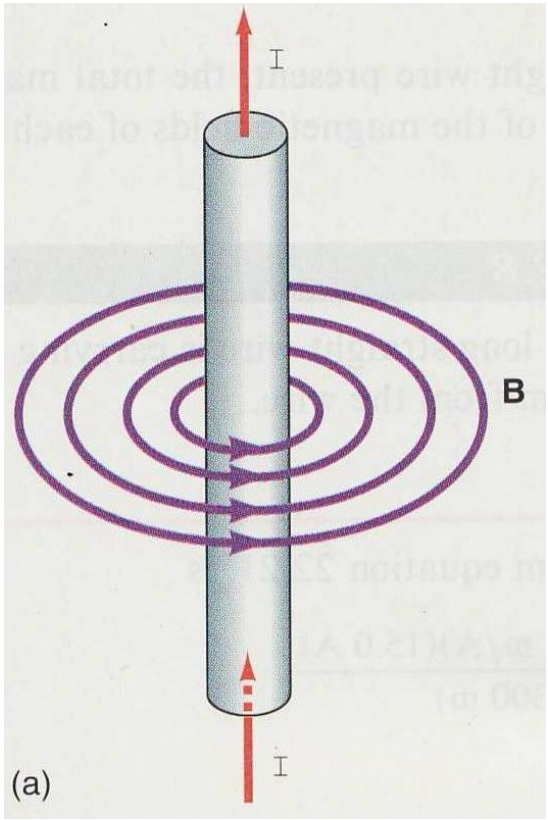


I've seen this galaxy many times, it's M87, part of the Virgo cluster, 50 – 60 MLY away, and I know it's an active galaxy, but I've never actually seen the jet myself . . .

Magnetic field around a long straight wire.

Let's review the second right hand rule :
•Fingers wrap around the current carrying conductor
•Thumb points in the direction of current flow.
•I checked, and for this rule, the thumb is **conventional current**

So, for the current I moving through the conductor shown at the right, which end (top or bottom) is connected to the + and which to the - side of the power supply?



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