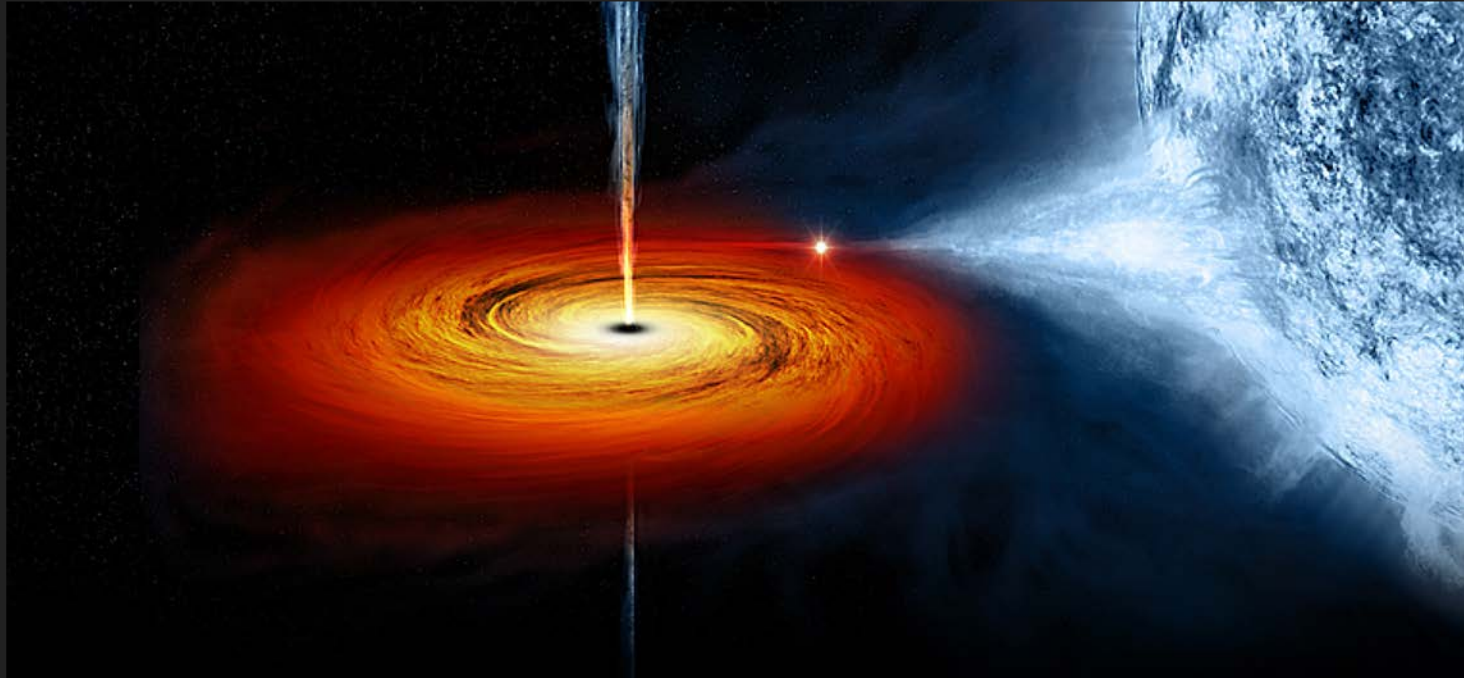


# Cygnus X-1

Bailey Conrad with Dr. Alex Storrs



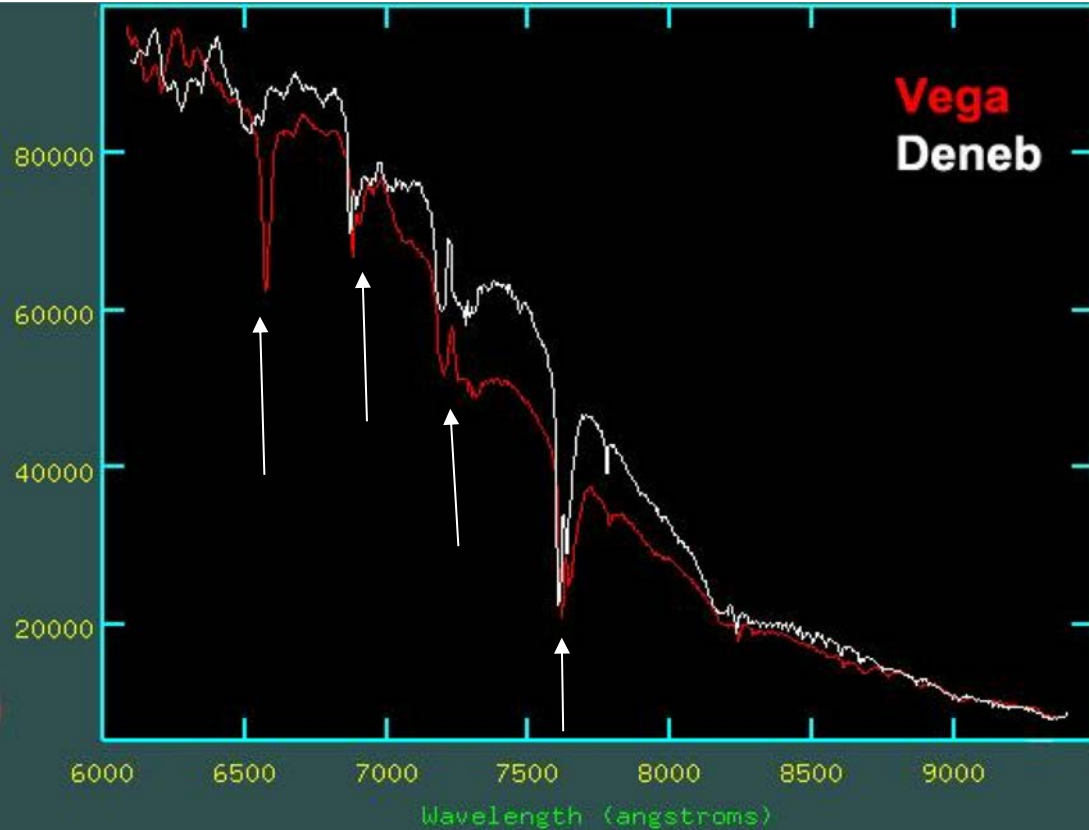
# Cygnus X-1 & HDE 226868

- Black hole and blue supergiant variable star
- About 15 and 30 solar masses
- Six day period

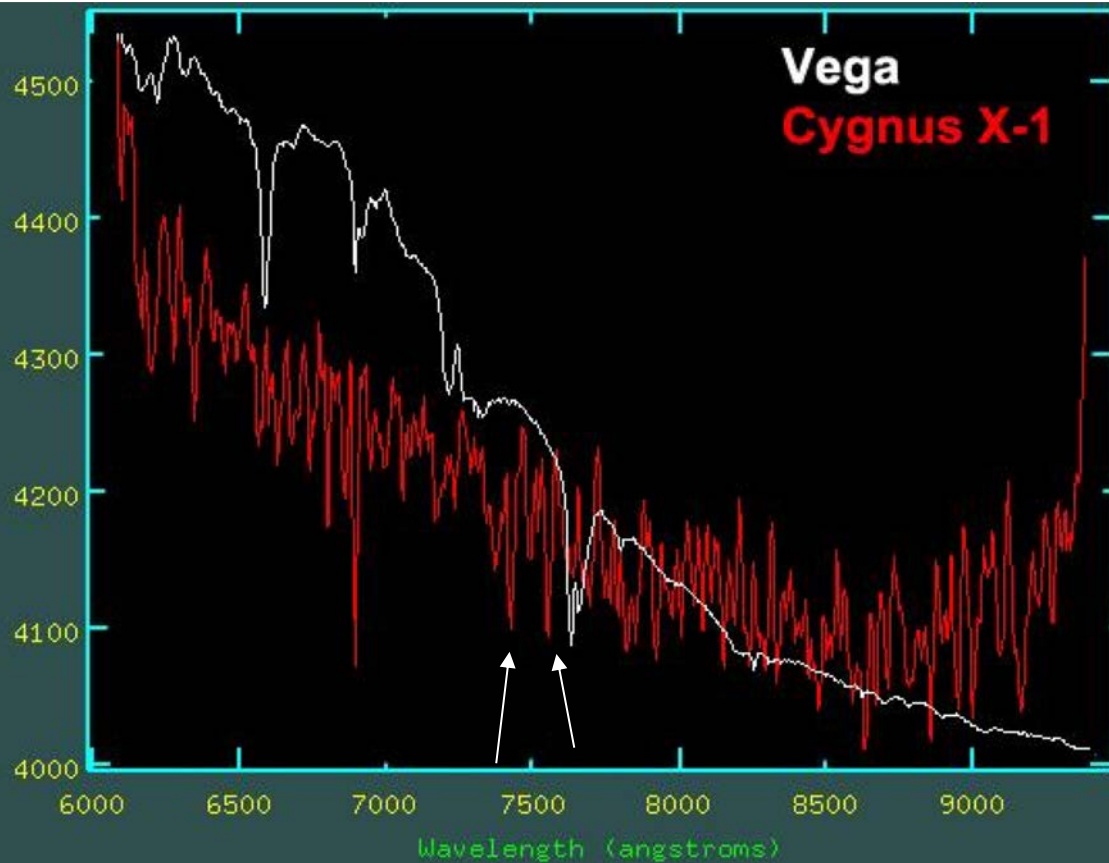
# Method

- Observe Cygnus X-1 using spectrograph
  - Deneb and Vega for comparison
- Compare variances in emission spectra
  - H-alpha (6563 Å)
  - He I (6678 Å)
  - He II (4686 Å & 4846 Å)
  - O[III] (5007 Å)

# Cygnus X-1 & HDE 226868



# Cygnus X-1 & HDE 226868



# Black Hole Firewalls and the Information Paradox

Carson Goettlicher with Dr. Tom Krause

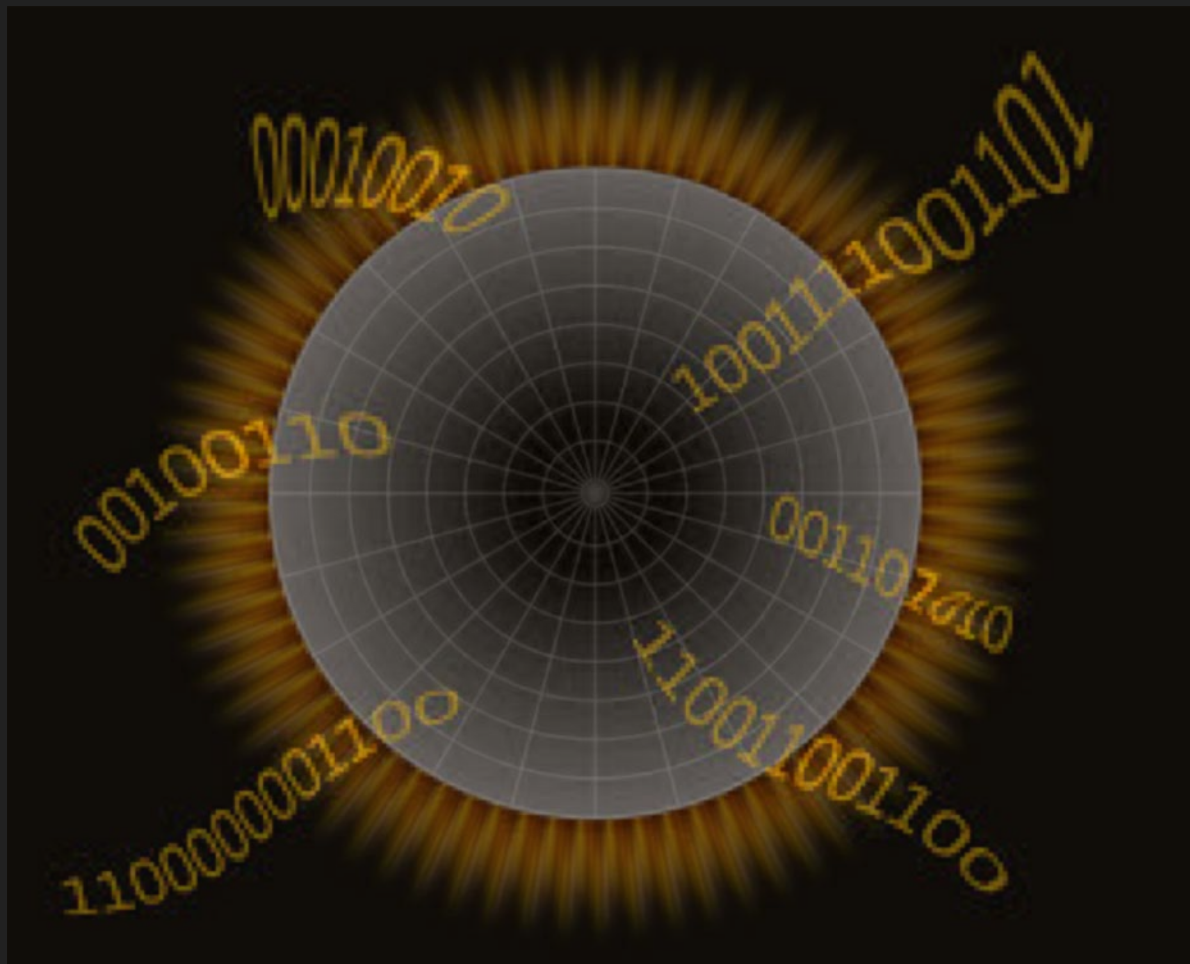


Schwarzschild  
Metrics

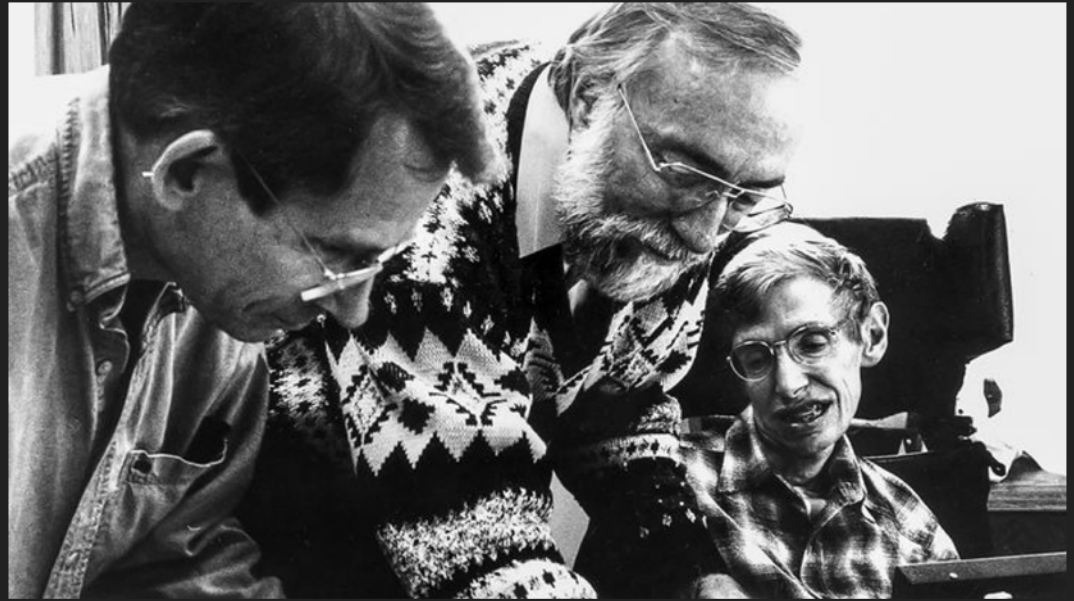
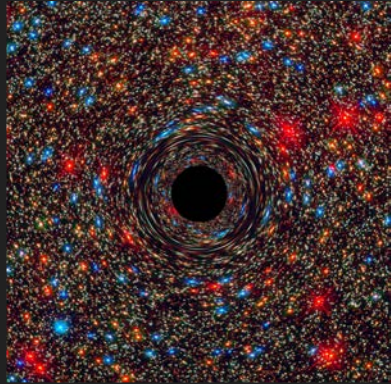
Quantum  
Entanglement

Firewall  
Thermodynamics

Information  
Paradox



# The 1997 Information Paradox Bet



## Stephen Hawking and Kip Thorne

Hawking Radiation (1974):  
Information is lost forever when  
crossing the event horizon

## John Preskill

Law of Conservation of Information:  
Information cannot be created  
destroyed only transferred

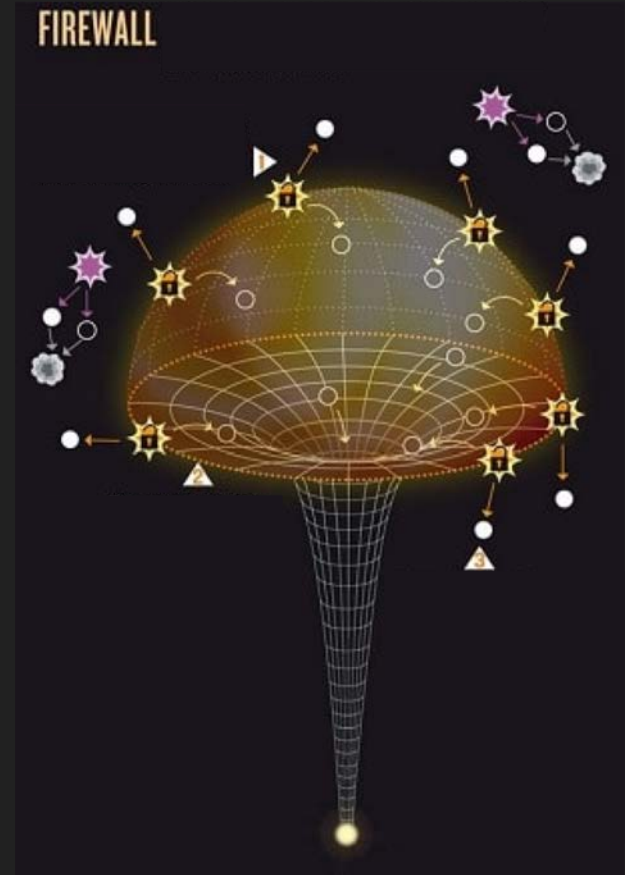


# Joseph Polchinski and AMPS

## Firewalls

The following three statements cannot all be true;

1. Hawking radiation is in a pure state
2. The information carried by the radiation is emitted from the region near the horizon, with low energy effective field theory valid beyond some microscopic distance from the horizon
3. The infalling observer encounters nothing unusual at the horizon



# Information Paradox

Law of Conservation of Information:  
Information cannot be created nor destroyed, only transformed

