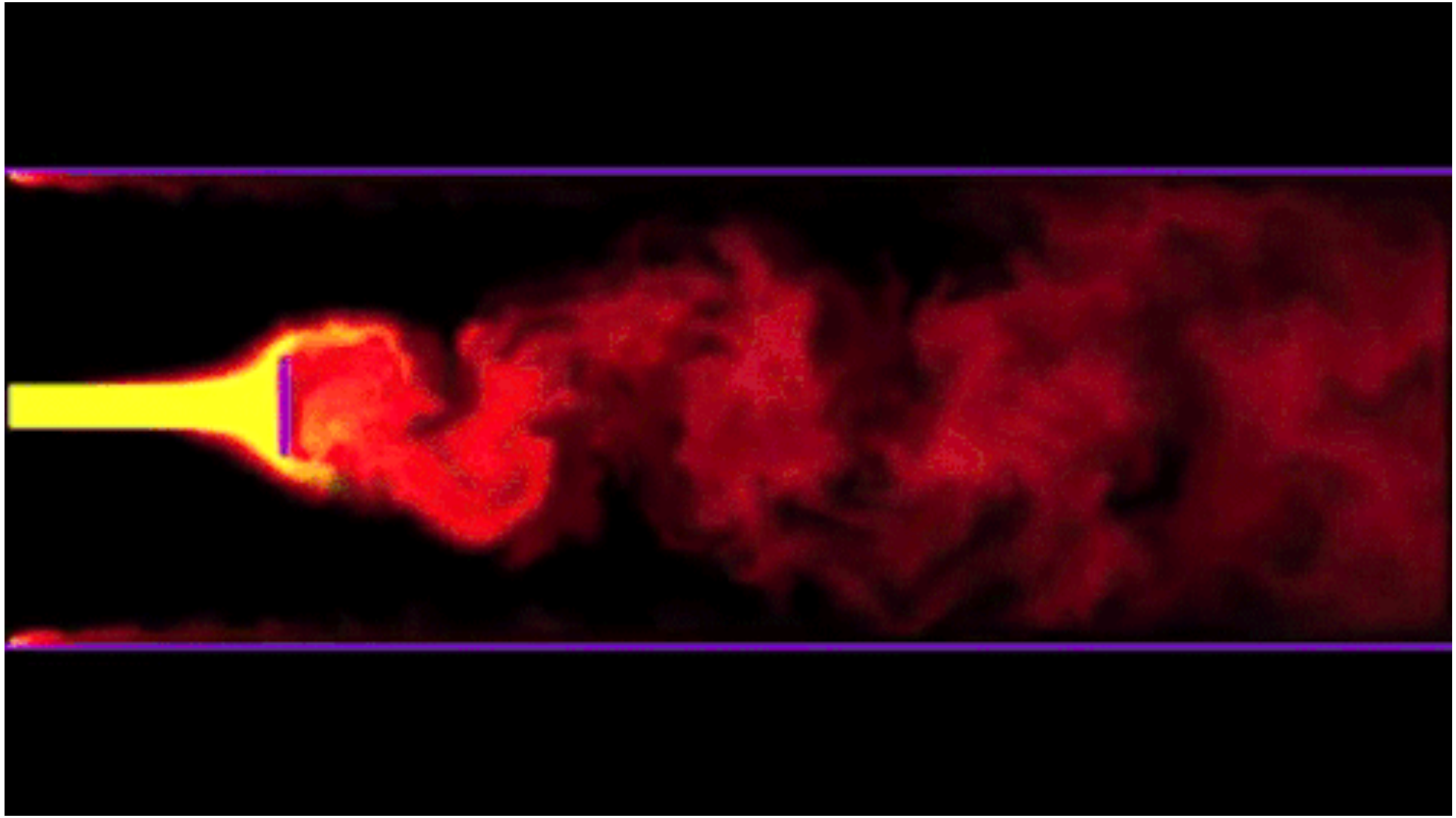
Class 12 – Mar 3rd, 2020

Turbulence leads to viscous-like behavior



1973A&A....24..337S

Astron. & Astrophys. 24, 337–355 (1973)

Black Holes in Binary Systems. Observational Appearance

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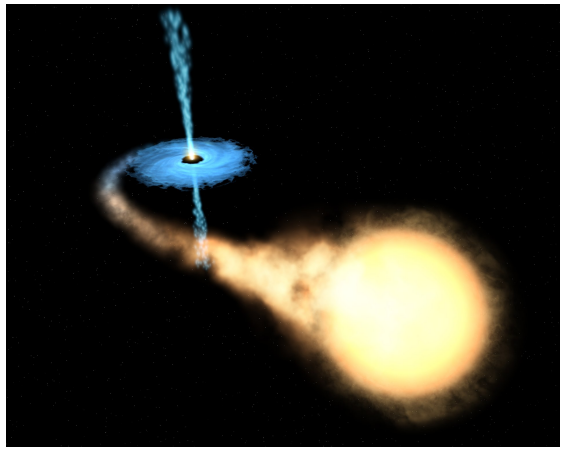
Received June 6, 1972

Summary. The outward transfer of the angular momentum of the accreting matter leads to the formation of a disk around the black hole. The structure and radiation spectrum of the disk depend, mainly on the rate of matter inflow $\dot{M}$ into the disk at its external boundary. The dependence on the efficiency of mechanisms of angular momentum transport (connected with the magnetic field and turbulence) is weaker. If $\dot{M} = 10^{-9} - 3 \cdot 10^{-8} \frac{M_\odot}{\text{year}}$ the disk around the black hole is a powerful source of X-ray radiation with $h\nu \sim 1 - 10$ keV and luminosity $L \approx 10^{37} - 10^{38}$ erg/s. If the flux of the accreting matter decreases, the effective temperature of the radiation and the luminosity will drop. On the other hand, when $\dot{M} > 10^{-9} \frac{M_\odot}{\text{year}}$ the optical luminosity of the disk exceeds the solar value. The main contribution to the optical luminosity of the black hole arises from reradiation of that part of the X-ray and ultra-violet energy which is initially produced in the central high temperature regions of the disk and which is then absorbed by the low temperature outer regions. The optical radiation spectrum of such objects must be saturated by broad recombination and resonance emission lines. Variability, connected with the character of the motion of the black hole, with gas flows in a binary system and with eclipses, is possible. Under certain conditions, the hard radiation can evaporate the gas. This can counteract the matter inflow into the disk and lead to autoregulation of the accretion.

If $\dot{M} \gg 3 \cdot 10^{-8} \frac{M_\odot}{\text{year}}$ the luminosity of the disk around the black hole is stabilized at the critical level of $L \approx 10^{38} \frac{M}{M_\odot} \frac{\text{erg}}{\text{s}}$. A small fraction of the accreting matter falls under the gravitational radius whereas the major part of it flows out with high velocity from the central regions of the disk. The outflowing matter is opaque to the disk radiation and completely transforms its spectrum. In consequence, at the supercritical regime of accretion the black hole may appear as a bright, hot, optical star with a strong outflow of matter.

Key words: black holes – binary systems – X-ray sources – accretion



Rashid Sunyaev's words:

"We were young, enthusiastic and had no doubts that we were developing a gold mine. Every day and every night (I was working at that time till 3–4 a.m.) brought something unexpected and very interesting".

State Prize of the Russian Federation in Science and Technology 2017