Studies of active galactic nuclei in Kazakhstan

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Content.

Fesenkov Astrophysical Institute.

Figure 1: The geographical location of the Institute.

Fesenkov Astrophysical Institute.

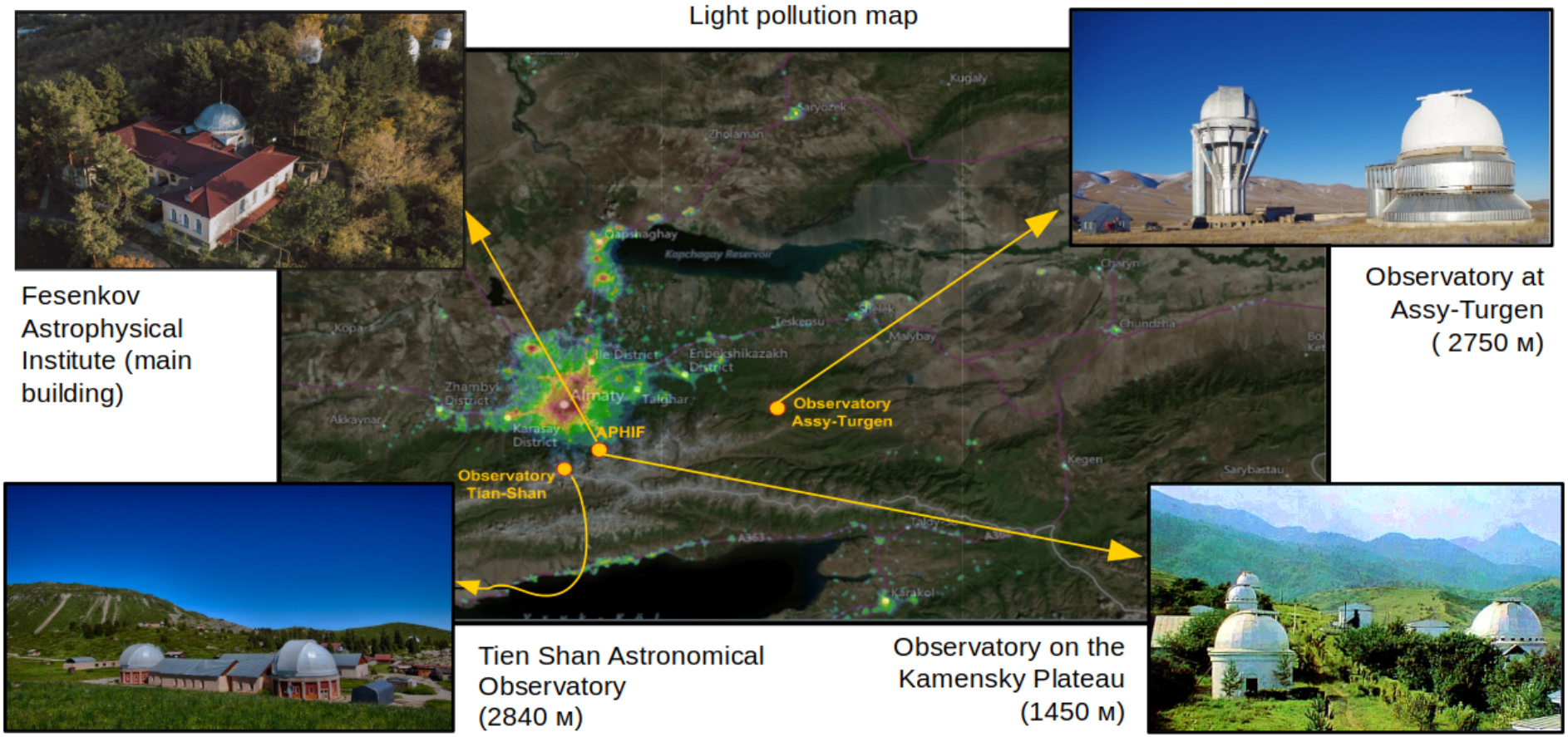


Figure 2: FAI main building and observation bases.

The beginning of AGN study at FAI. 1/2

Characteristics of AZT-8:

- D = 700 mm
- F_{main} = 2800 mm
- F_{Cass} = 11000 mm

During the observation on AZT-8 emission lines were detected in 14 out of 20 Mrk galaxies.

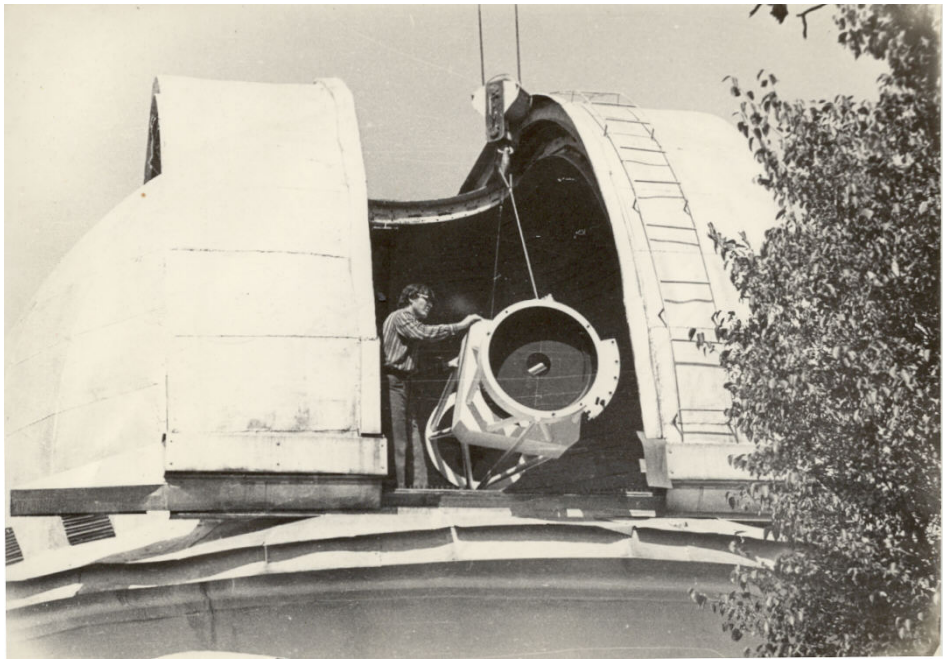


Figure 3: Installation of the AZT-8, 1964.

The beginning of AGN study at FAI. 2/2

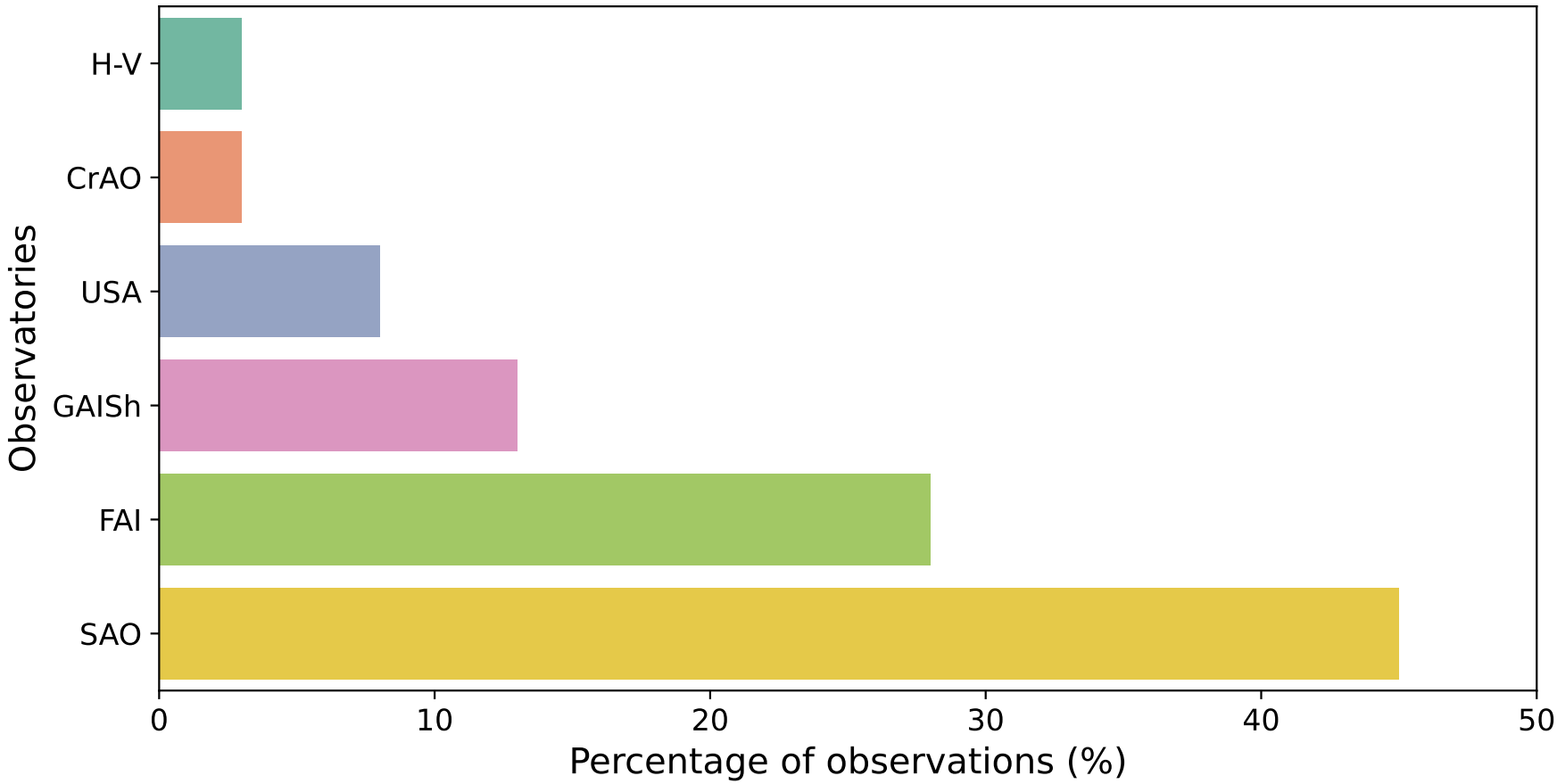


Figure 4: The share of the first spectral studies of Markarian galaxies in Soviet and foreign observatories [Denisyuk2000, Denissyuk et al.2015].

Results of spectral research.

Mrk 1095 = Ark 120.

Basic data:

- Sy1 type,
- $\alpha(2000) = 05^h13^m37.87^s$,
  $\delta(2000) = -00°12'15.12"$,
- z = 0.03230.

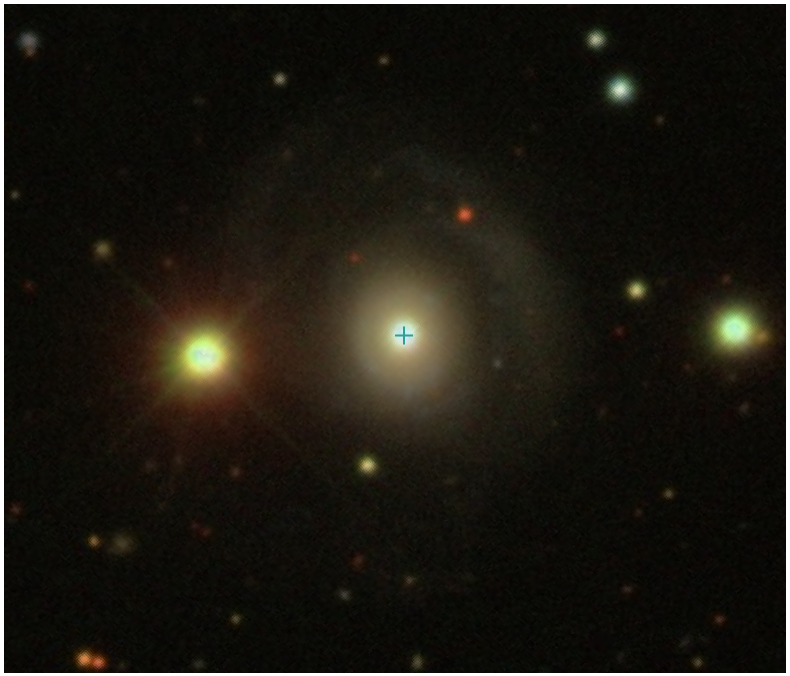


Figure 5: Mrk 1095. Image was taken from http://simbad.u-strasbg.fr/simbad/sim-id?Ident=Ark+120

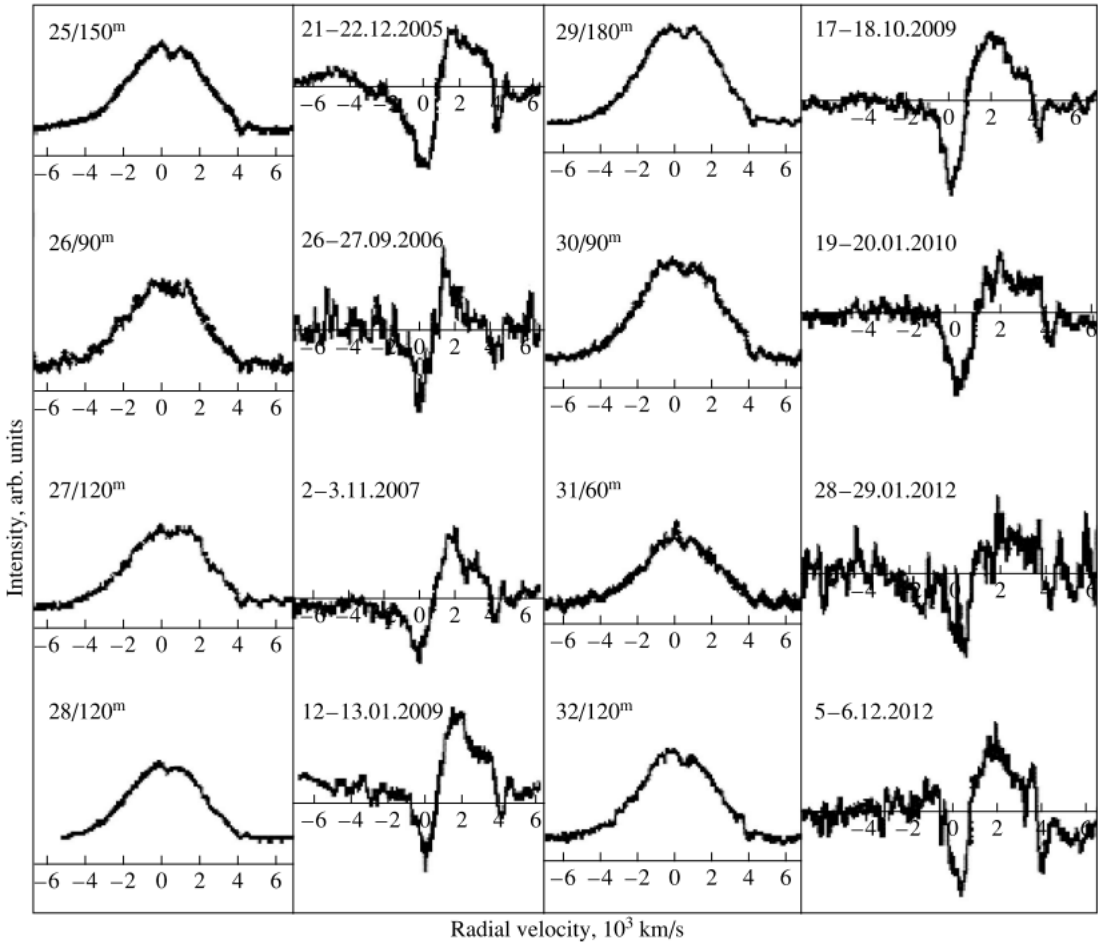
Results.

As a result of the study [Denissyuk et al.2015]

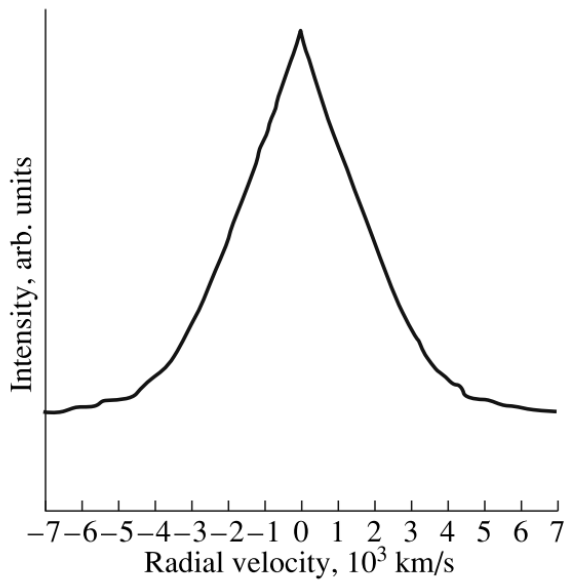
- velocities of emission objects,
- orbits of emission objects,
- mass of CB

were calculated.

Subtracted-Wing Spectrum (SWS).



(a) Fragments of H_{alpha} spectrograms and processing results (SWS) [Denissyuk et al.2015].



(b) Artificial contour of a wide component [Denissyuk et al.2015].

Radial velocities of emission objects.

The first results of radial velocities calculations:

- object A — $V_{A(init)} \approx 2000$ km s^{-1},
- object B — $V_{B(max)} \approx 3800$ km s^{-1},
- object C — $V_{C(init)} \approx 1000$ km s^{-1} $\rightarrow$ $V_C \approx 2500$ km s^{-1}.

Radial velocities of emission objects in 1976–2012.

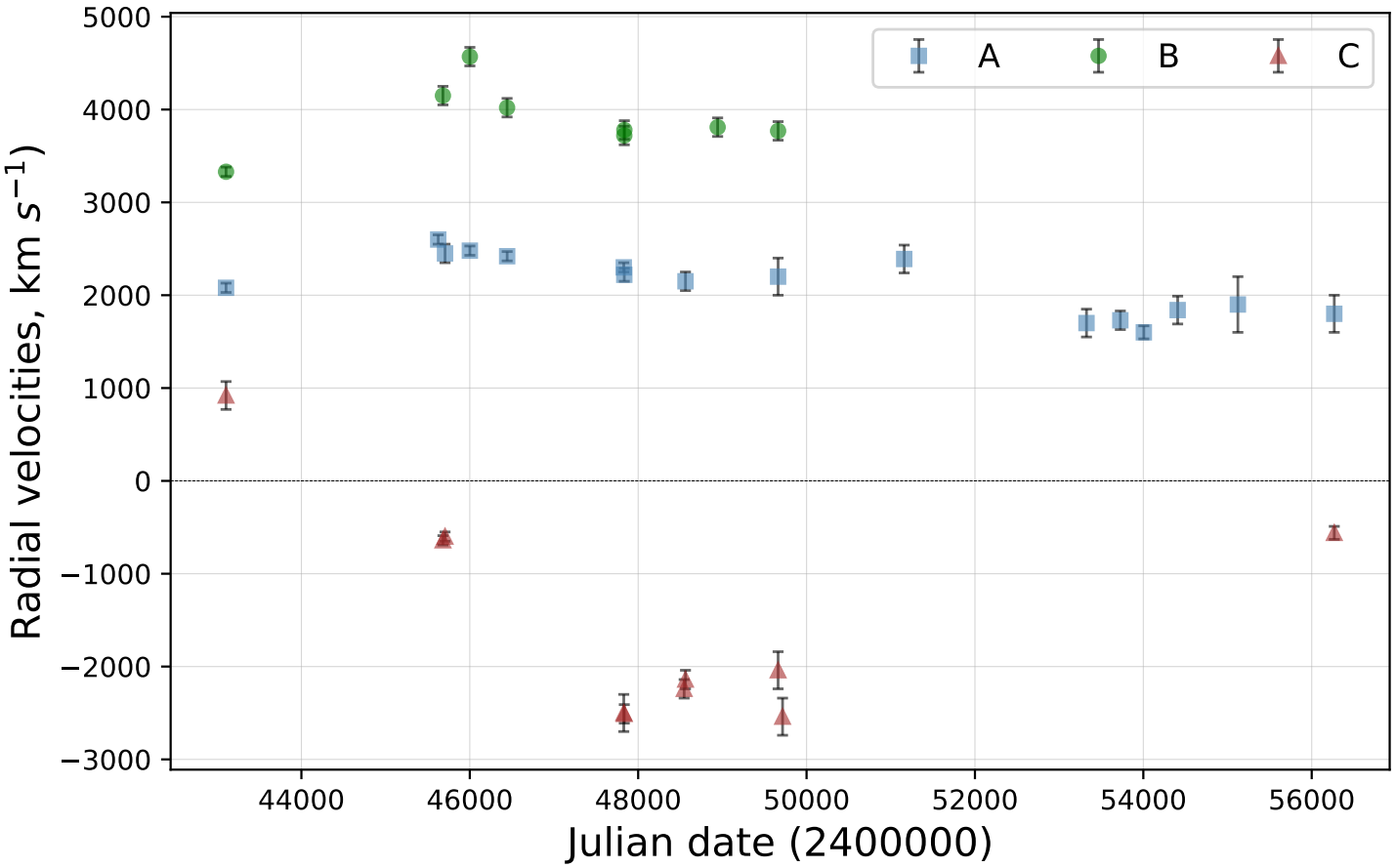


Figure 7: Radial velocities of three emission objects (A,B,C), Mrk 1095, 1976–2012 [Denissyuk et al.2015].

Orbits of emission objects. Equations [Denissyuk et al.2011].

$$\cos\psi = \frac{\tau c - r}{\tau \sin\phi}, \qquad V = \frac{V_r}{\cos\gamma\cos\phi}, \qquad a = \frac{M_{CB}G}{r^2},$$

where r and ϕ are the polar coordinates of the object in the orbital plane,

ψ is the angle between the line of sight and the orbital plane,

τ is the delay determined by the cross-correlation method,

γ is the angle between the velocity vector and the Y-axis,

V_r is the radial velocity,

M_{CB} is the mass of the central body,

G is the gravitational constant.

Orbits of emission objects.

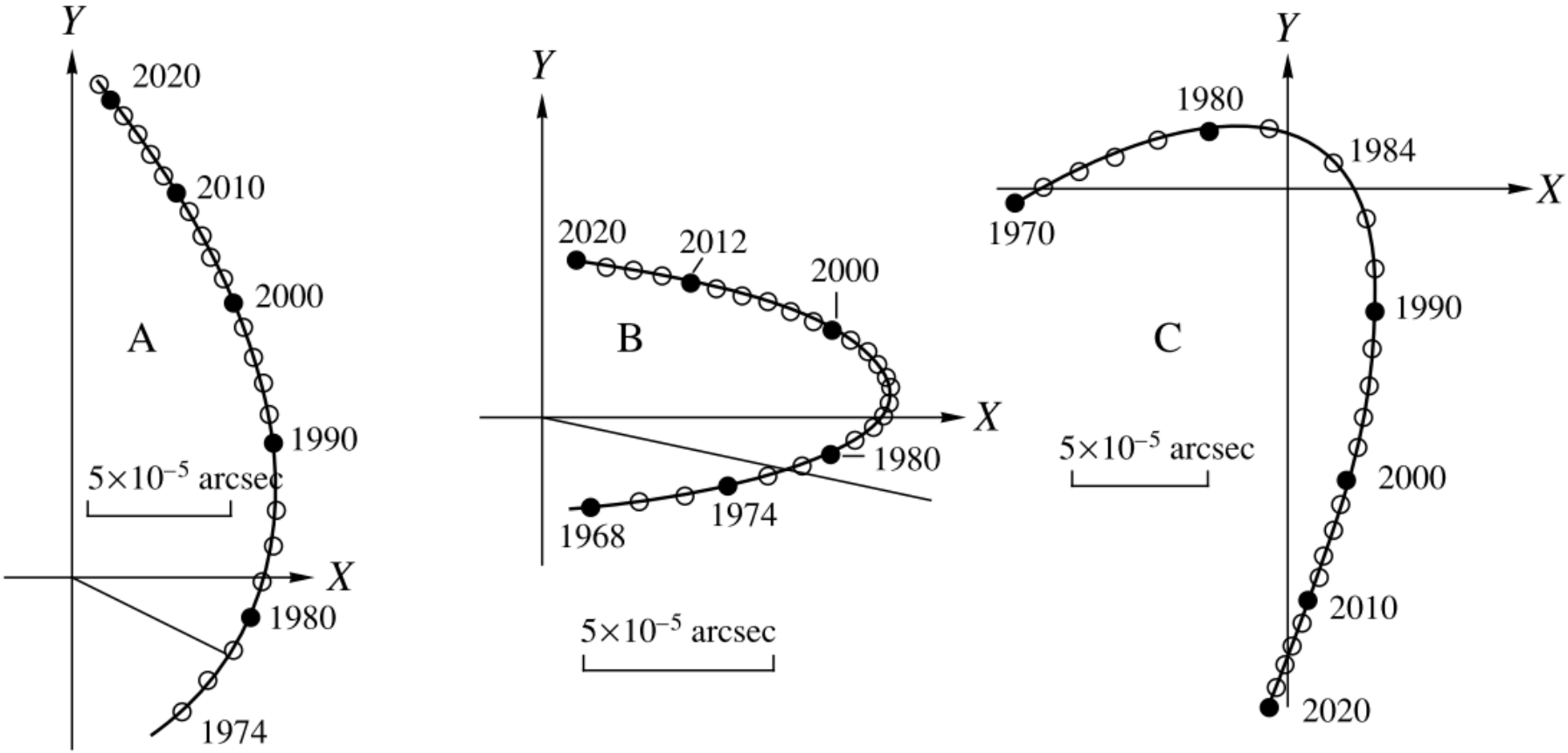
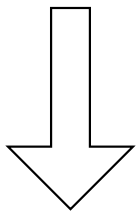


Figure 8: View of orbits for an observer on Earth [Denissyuk et al.2015].

Mass of the central body.

General parameter — mass of the CB.



Calculated value $M_{CB} \approx (1.675 \pm 0.028) \times 10^8 M_{\odot}$.

The probable binarity of the nucleus.

Two peaks were detected in the H_β line [Li et al.2019]. The behavior of the peaks is characterized by:

- strong variety in time;
- merging into one peak during some epochs;
- the estimated frequency of changes.

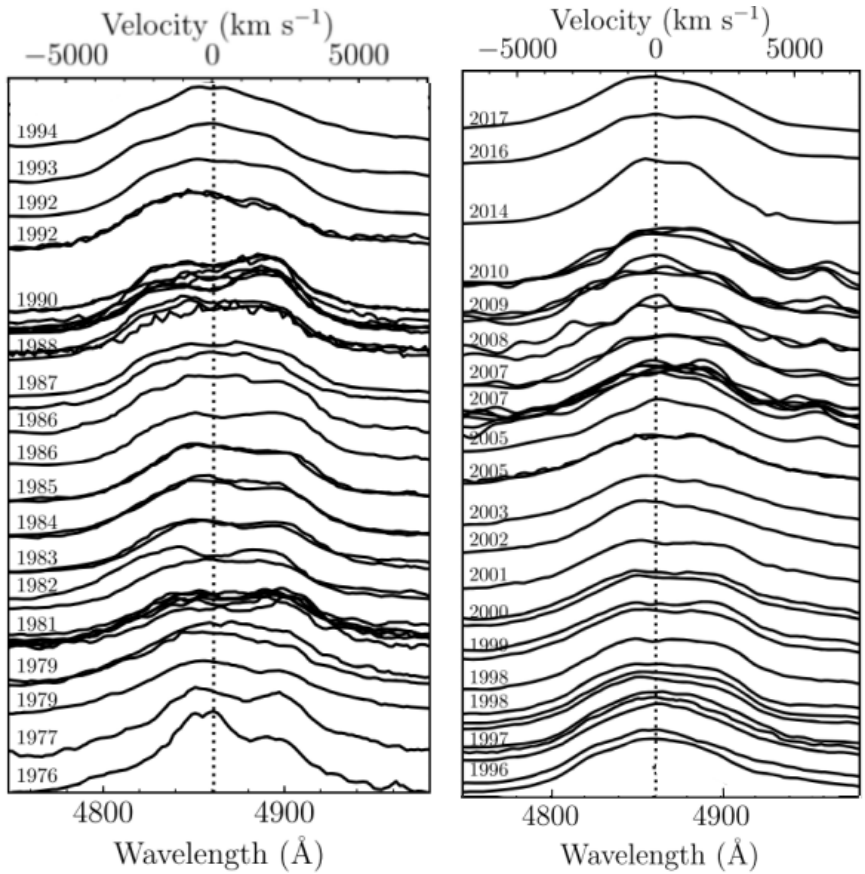


Figure 9: H_β profiles in 1976–2017. The figure is reproduced from [Li et al.2019].

Results of theoretical research.

Directions of theoretical researches.

Directions of theoretical researches at FAI:

1. construction of models of the outflow of matter in the radiation field of the AGN;
2. creation of a multicomponent evolutionary model of the AGN taking into account the interaction of three components in a $\sim$1 pc region: a stellar cluster, a gas medium and a supermassive black hole.

Models of AGN and BAL in spectrum.

Broad absorption lines (BAL)
[Vilkoviskij2001]

$\sim$12% quasars

$\sim$50% SG

The unified model of AGN.

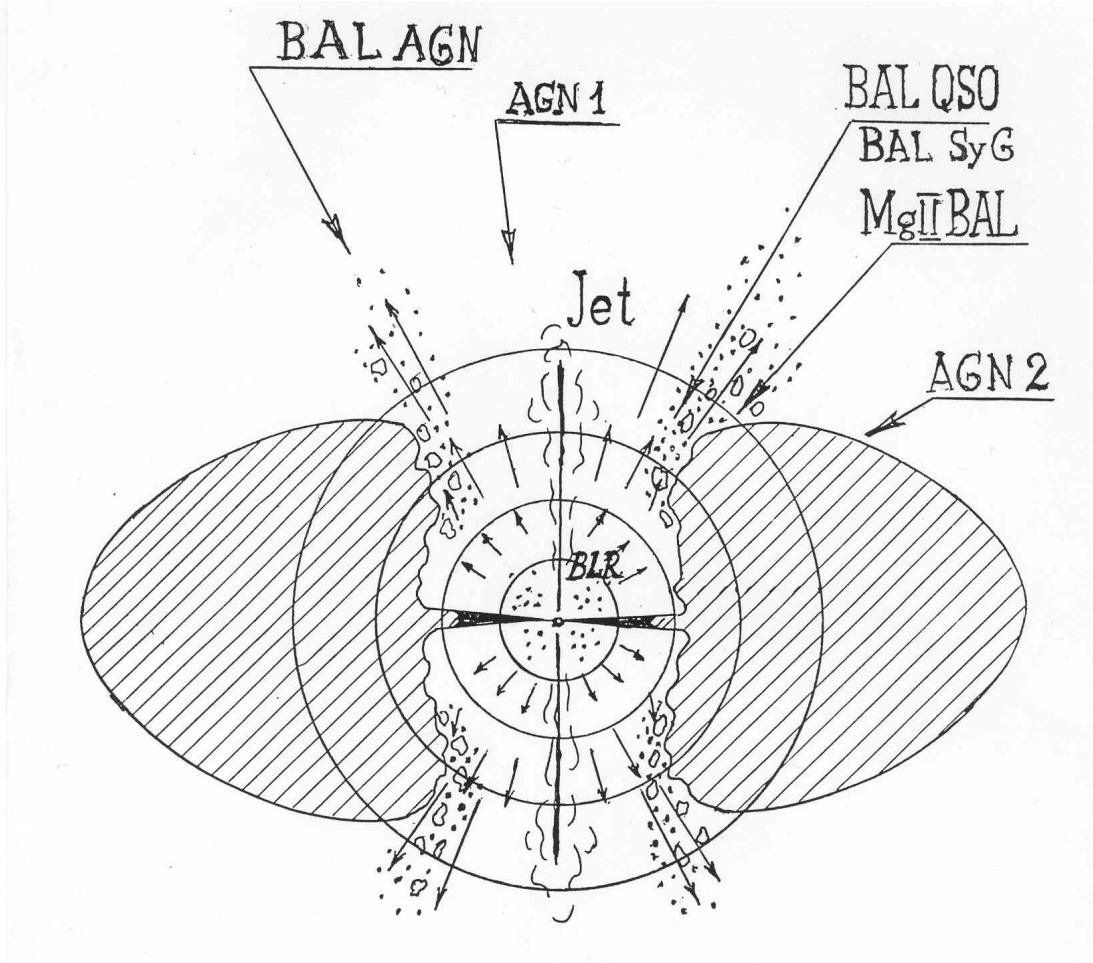


Figure 10: The unified model of AGN. The figure is reproduced from [Vilkoviskij et al.2004].

Base of theory.

The theory is based on the solution of a system of equations [Vilkoviskij1996a, Vilkoviskij1996b, Vilkoviskij1999]:

- radiation gas dynamics in two-phase media (cold clouds in hot gas),
- radiation transfer in spectral lines and continuum,
- photoionization balance.

Conclusion.

The work performed at this time:

- calculation of absolute fluxes;
- digitizing of the astroplates.

Thank you for your attention!

References. I

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