Keck observations of G2 and SgrA*

for the

UCLA Galactic Center Group

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The story so far…

G2 is an intriguing source:

- Very red
- Line emission with an evolving FWHM
- Shows gas that seems to be tidally interacting with the BH
- Is on a highly eccentric orbit and passing the BH in early 2014

Many things are uncertain and under intense discussion:

- How much gas is there?
- Is this a compact gas cloud (how could it have survived?) or is it stellar in nature (which seems more natural)?
- Will it have any observable impact on SgrA*'s emission?

Gillessen et al. 2012, 2013a,b
Phifer et al. 2013
Eckart et al. 2013

And now come the 2013 data …

… and it changes …

… nothing!

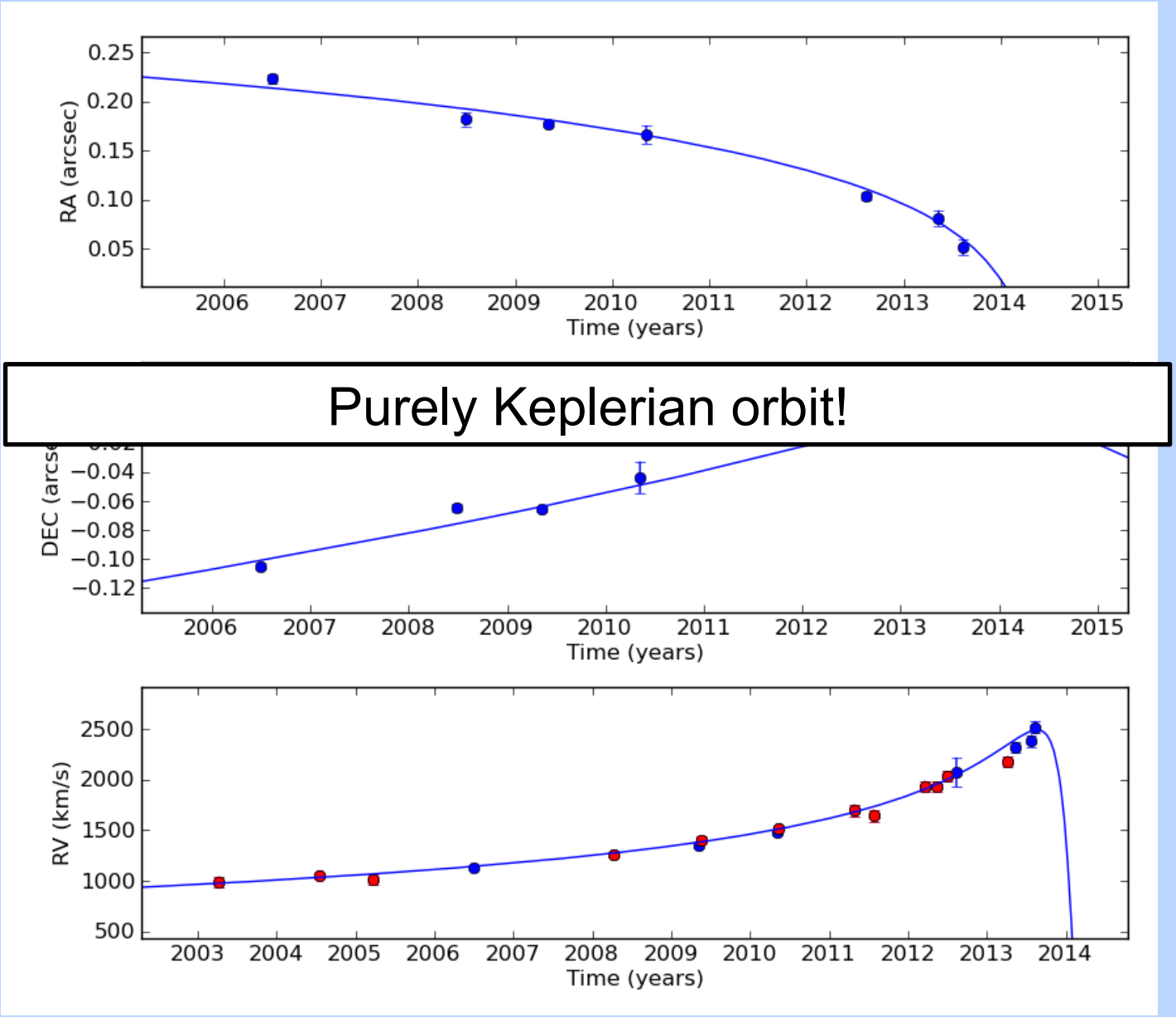
Kinematics

Constructing a self-consistent orbit

Two important points:

- Use the Br-Gamma emission for BOTH radial velocities and proper motions
- Use consistently our well-calibrated K' reference frame, in which we derive the parameters of the gravitational potential (M_{BH}, R_0, X_0, Y_0, Vel_X, Vel_Y, Vel_Z)

Updated Br-Gamma based orbit



Purely Keplerian orbit!

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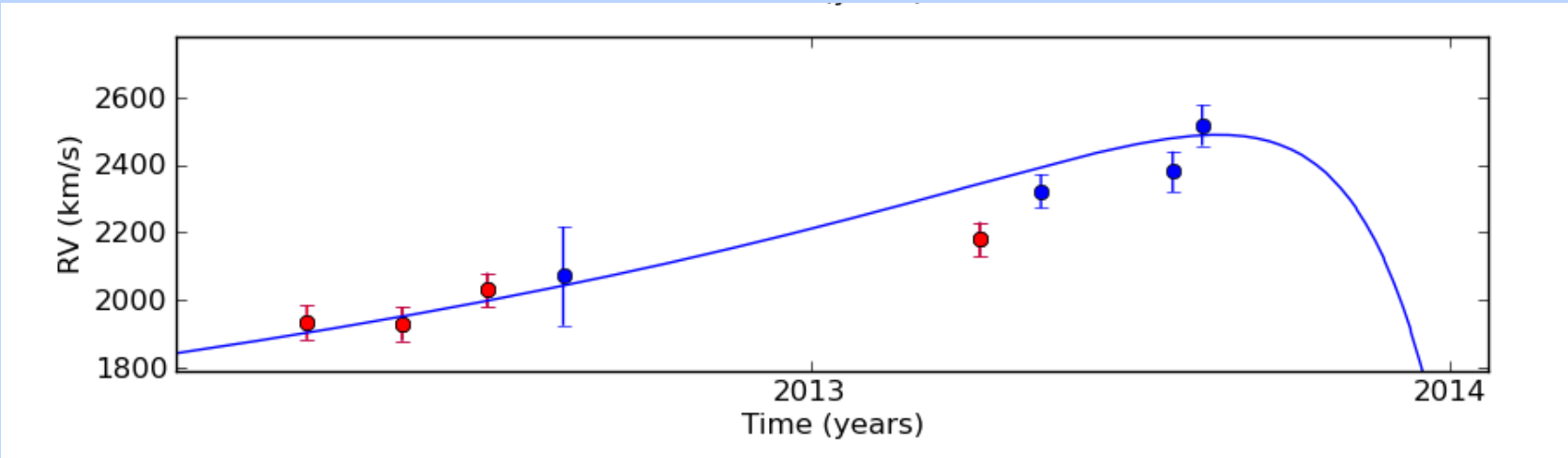
Updated Br-Gamma based orbit



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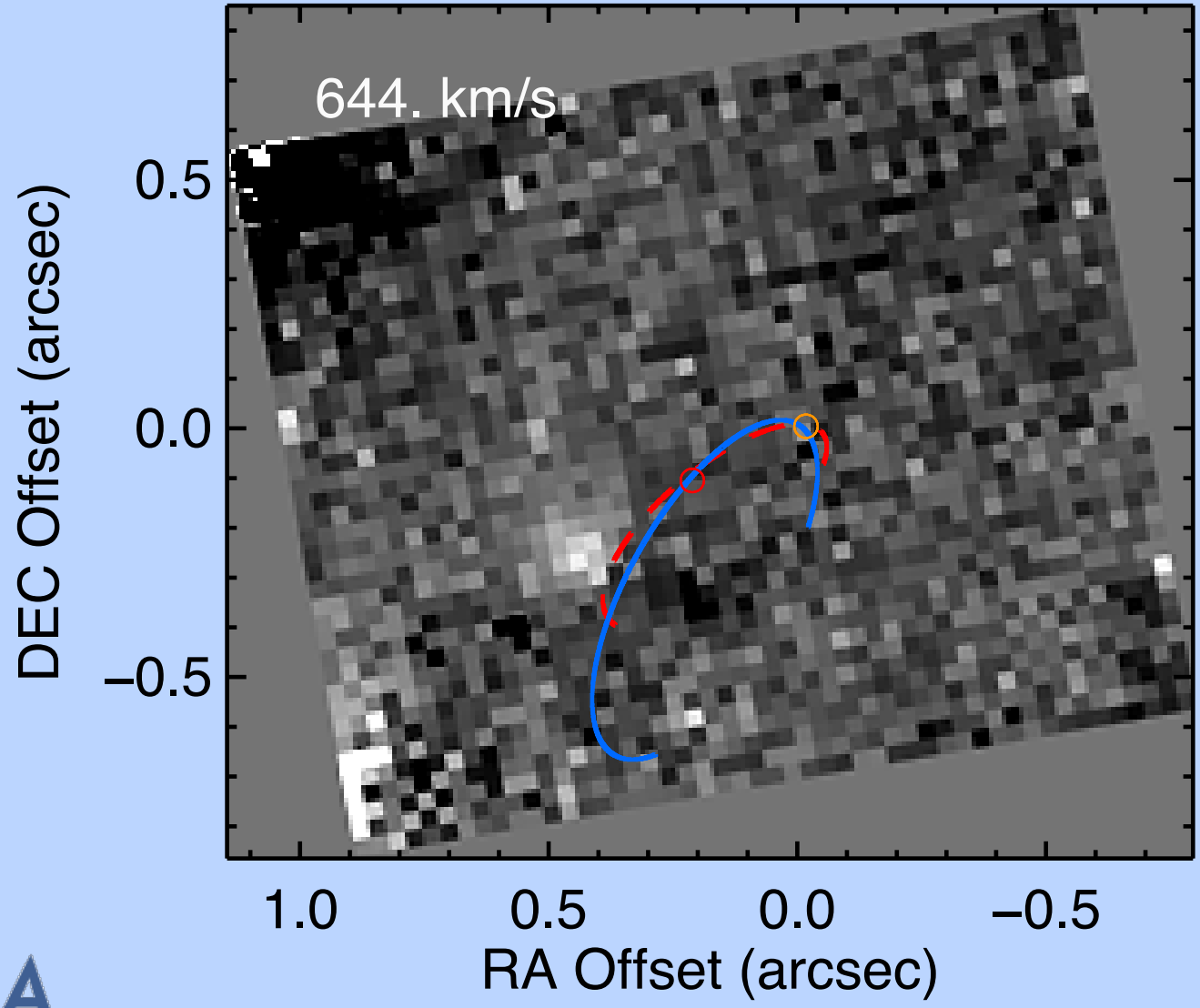
Comparison of Br-Gamma orbits

	UCLA 2012	MPE 2013	UCLA 2013
ecc	0.981 ± 0.006	0.970 ± 0.003	0.965 ± 0.011
Incl [deg]	121 ± 3	118 ± 2	113 ± 3
Ω [deg]	56 ± 11	82 ± 4	77 ± 10
ω [deg]	88 ± 6	97 ± 2	92 ± 4
T_0 [yr]	2014.21 ± 0.14	2014.25 ± 0.06	2014.21 ± 0.13
P [yrs]	276 ± 111	391 ± 66	264 ± 139

Phifer et al. 2013 Gillessen et al. 2013b

G2 and gas features

A tail of G2?
(is not on the orbit)



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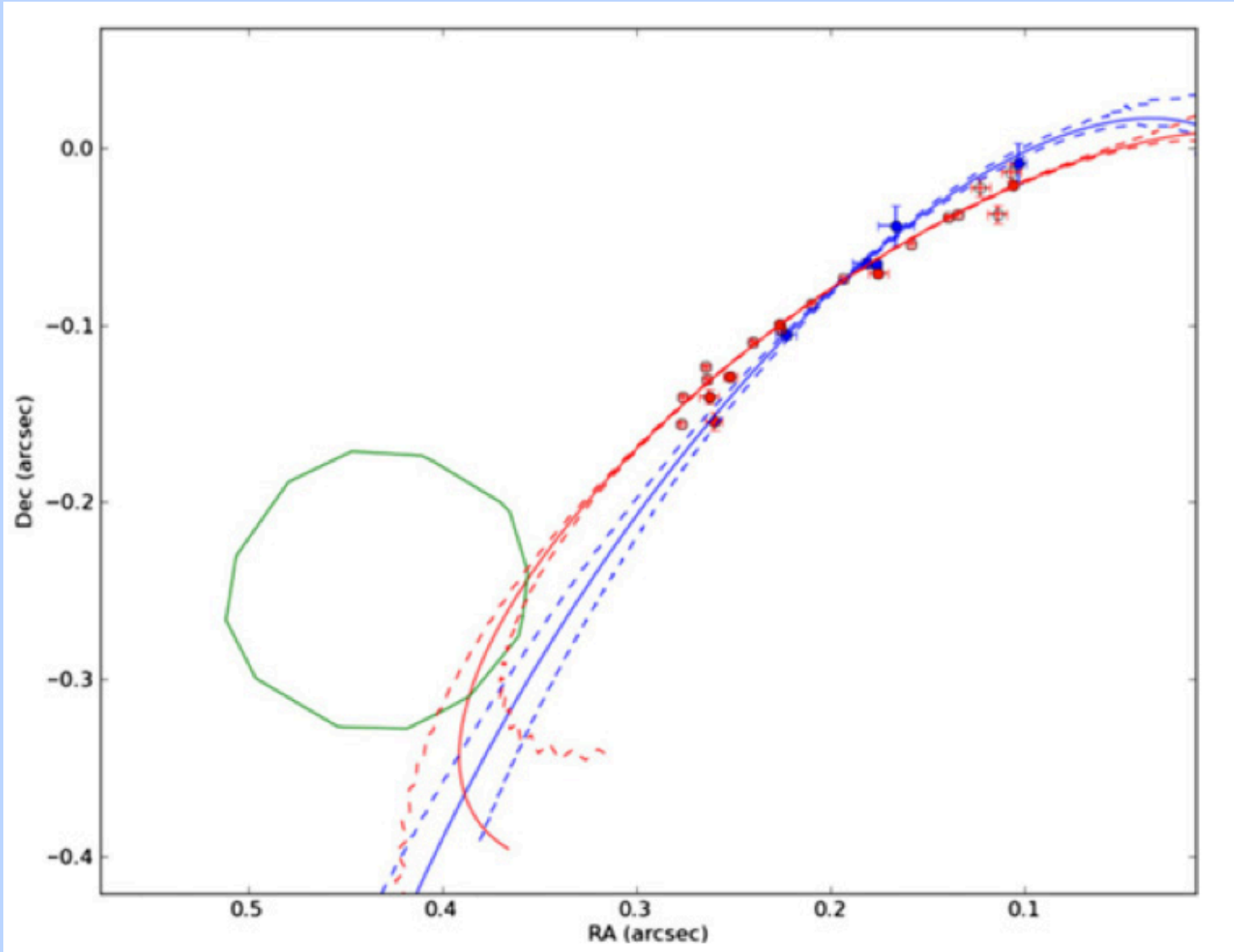
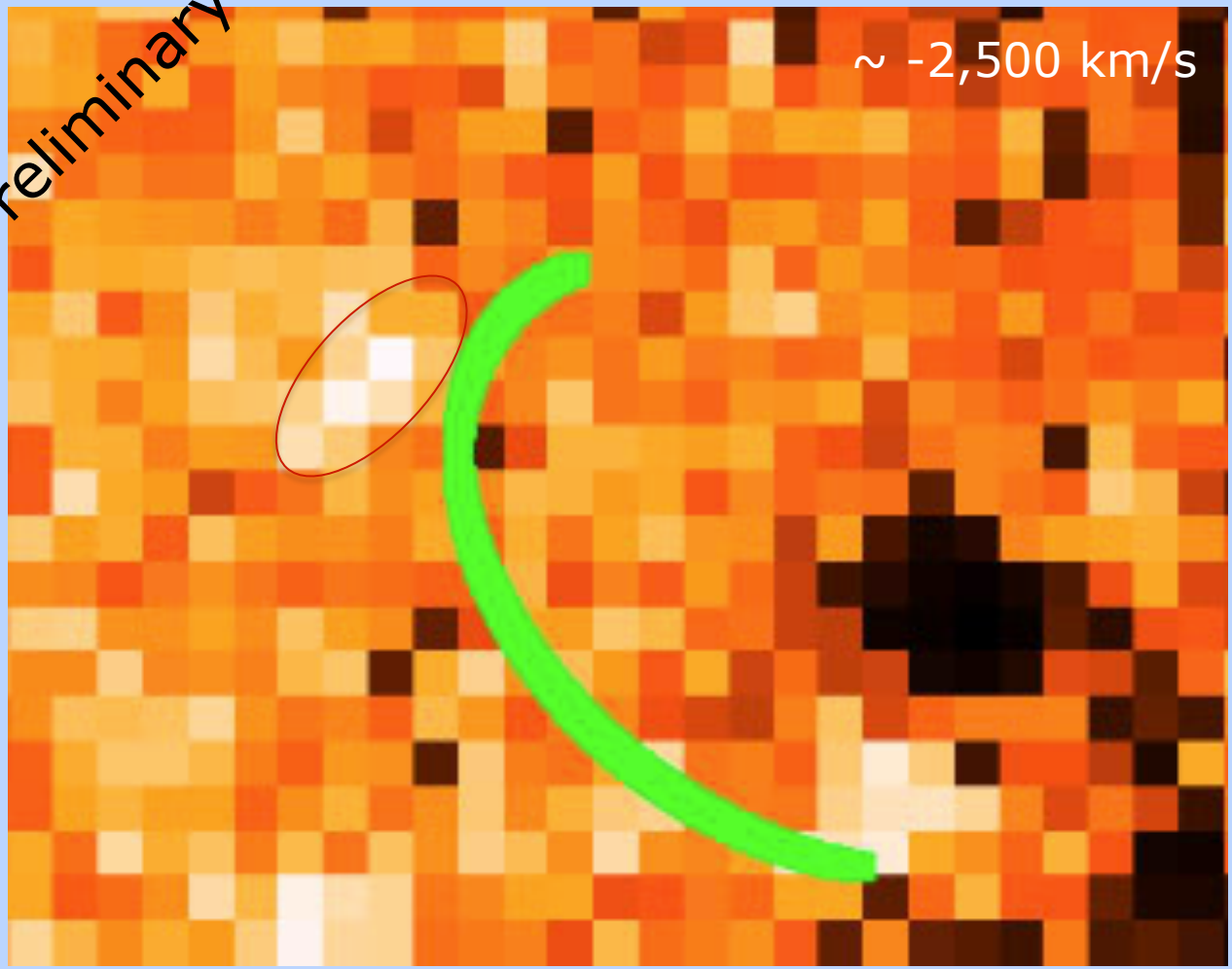


Phifer et al. 2013

A blue-shifted head?
(is not on the orbit)



July+August 2013

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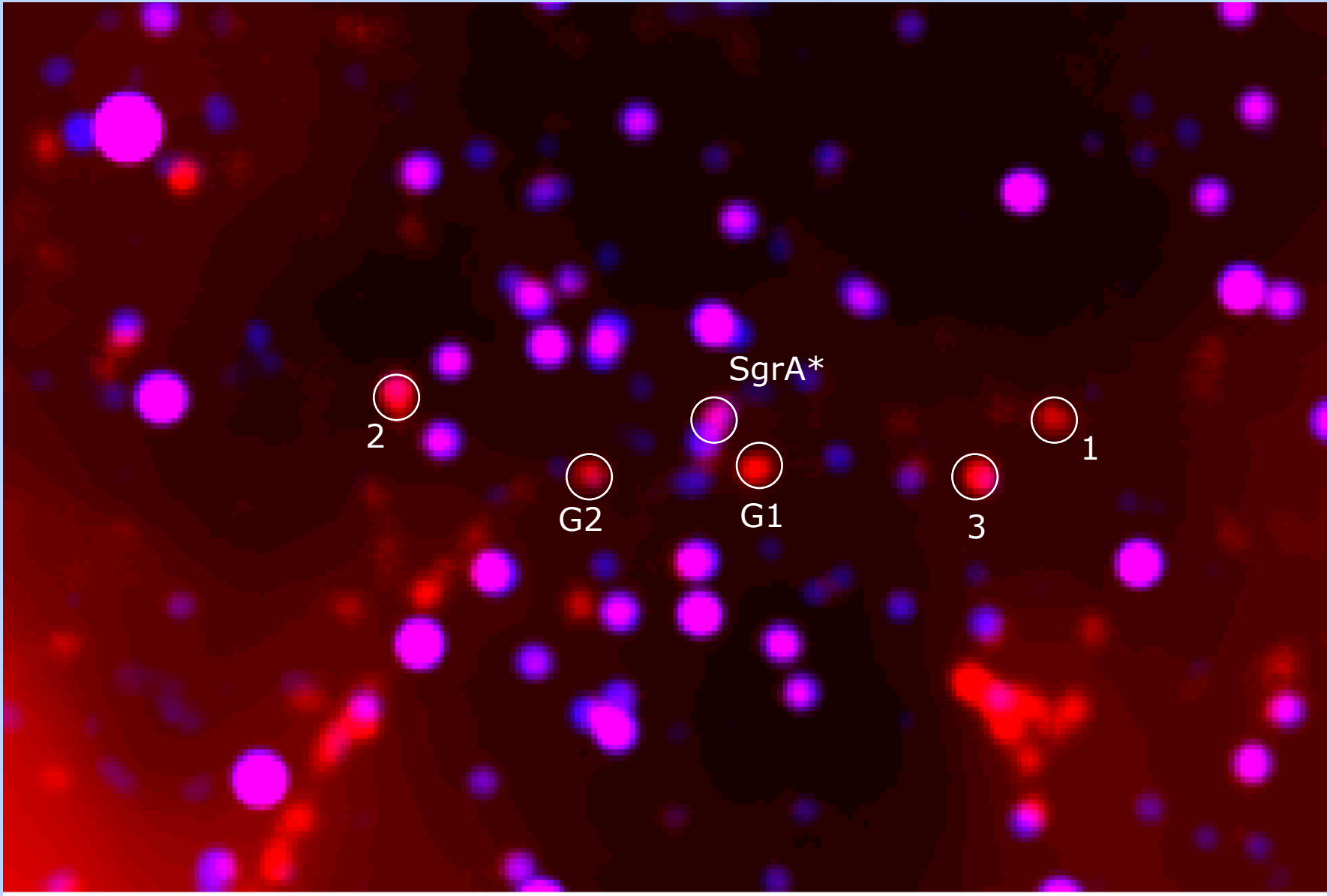
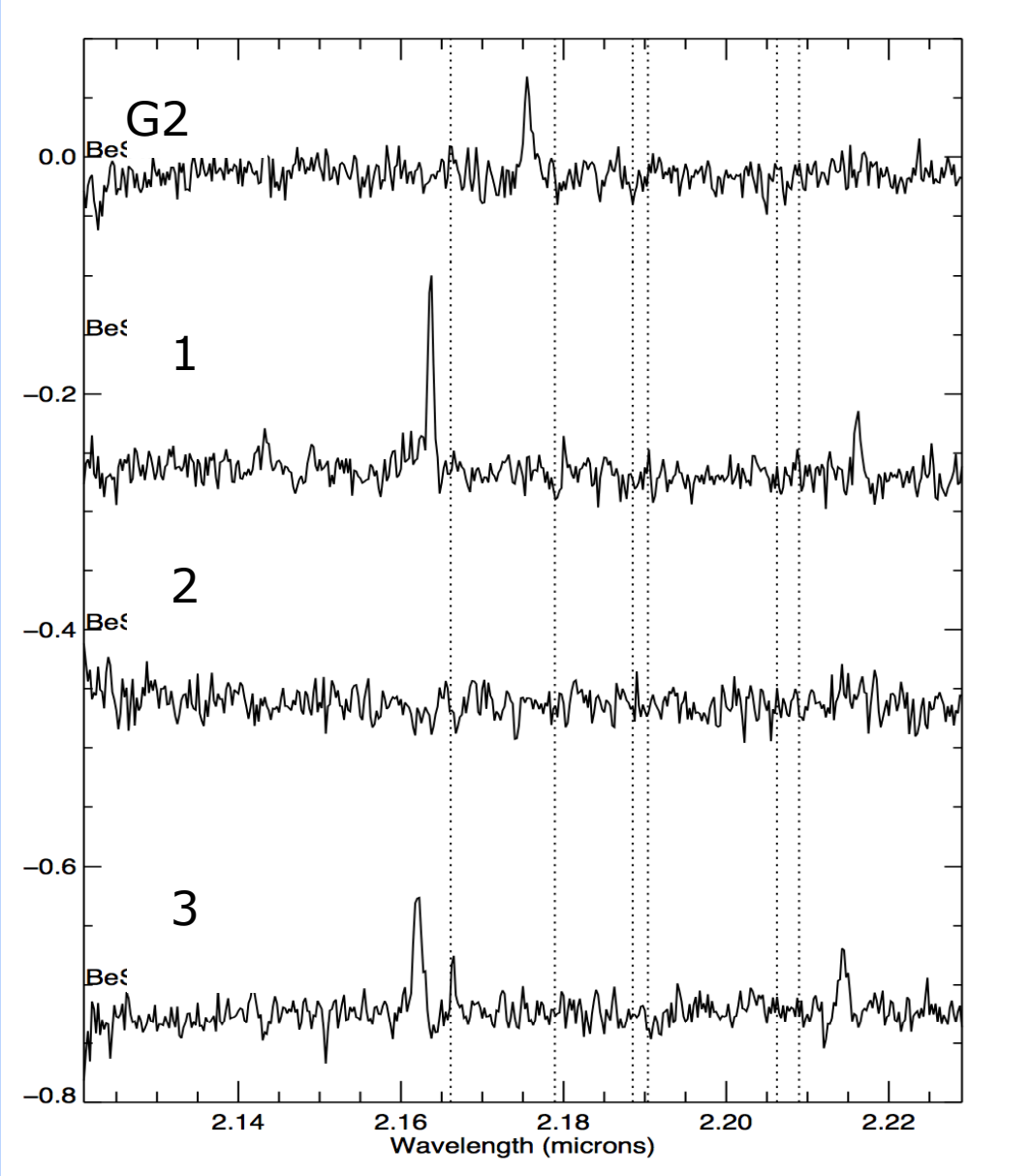
G2 is not unique!

Red emission-line sources in the GC



Red emission-line sources in the GC



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Assessing possible changes in SgrA*'s variability

Sgr A* in 2013

Date	Sgr A* Kp Magnitude
2011 May	16.1
2012 July	16.5
2013 April	16.8
2013 July	> 17

Important to infer IF and WHEN SgrA*'s variability characteristics changed

Will G2 trigger a distinct new variability state of SgrA* and if so **when** did the transition occur?

Statistical methodology needed!

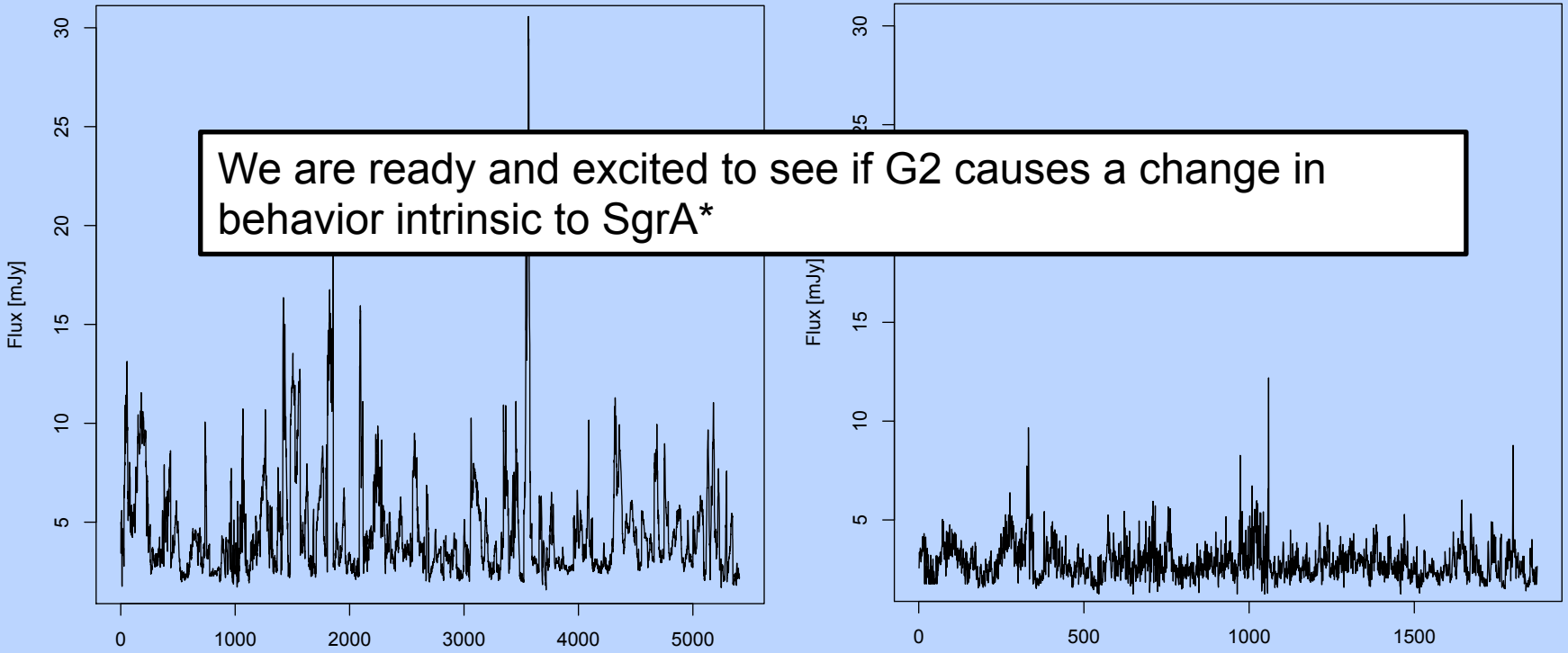
Idea of state changed for SgrA* brought forward by Dodds-Eden et al. 2010 (but see Witzel et al. 2012), however no timing information was used.

We have developed a methodology that fully incorporates timing information! -> *Hidden Markov Model*

Meyer et al., basically done ☺

In the past SgrA* itself had only **one** state

However, our algorithm finds a noise-dominated and a source-dominated state in the measurements



We are ready and excited to see if G2 causes a change in behavior intrinsic to SgrA*

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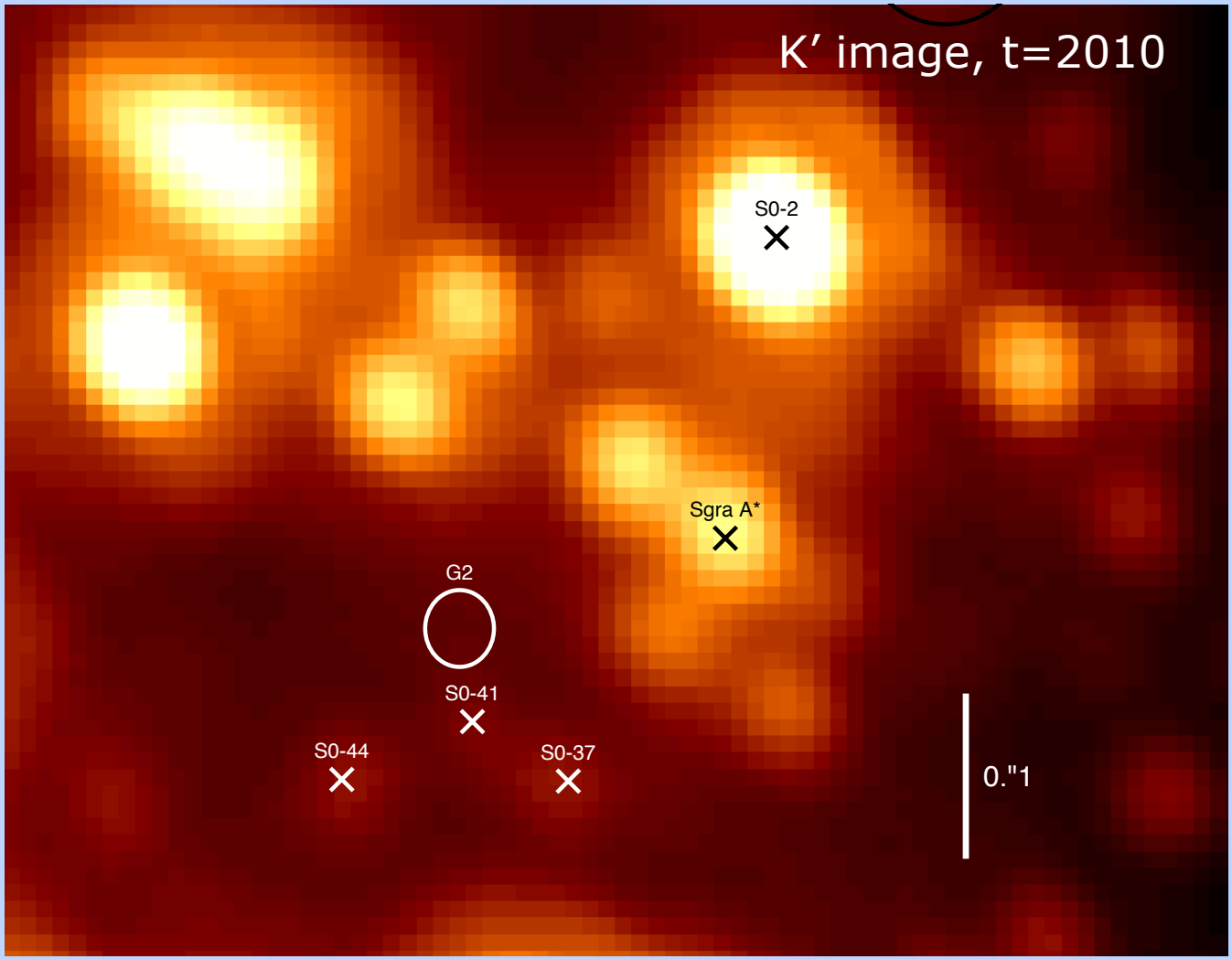
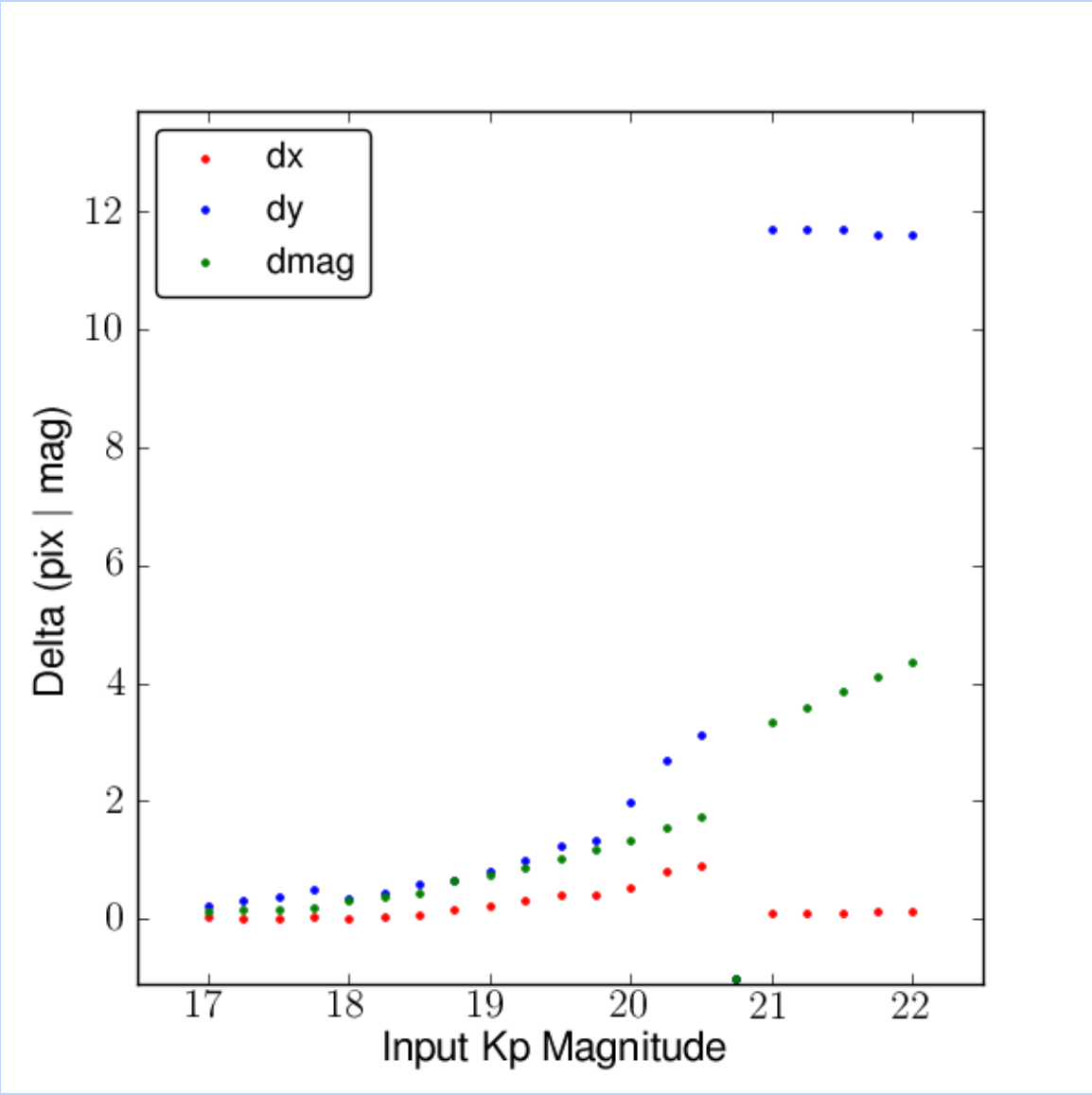
Conclusions

- G2's motion is sufficiently described by a Keplerian orbit
- The "tail" and blue-shifted "head" might be independent gas structures
- There are plenty of G2-like sources around
- The impact on SgrA*'s emission might be very subtle and advanced statistics is needed and has been developed

There is no K' counterpart to G2 down to K_{mag} = 20

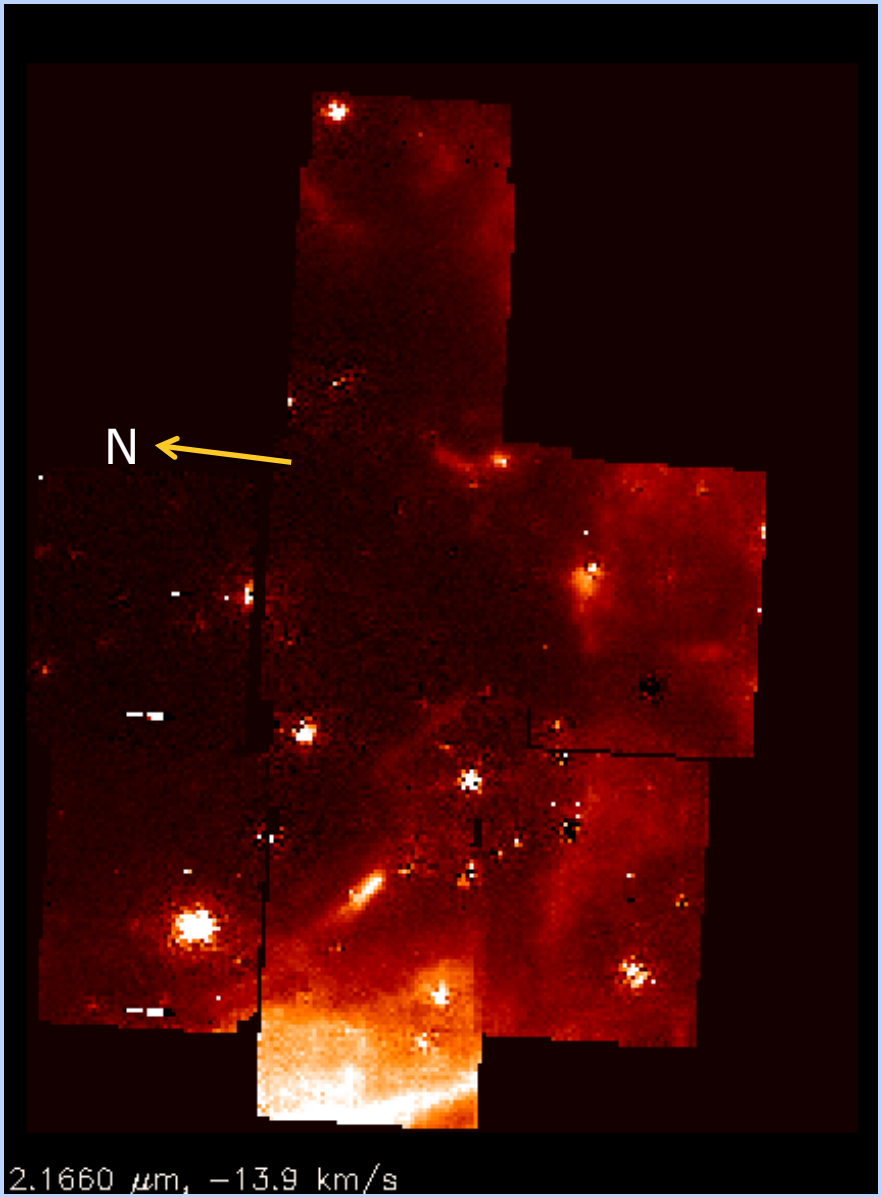


New K' limit of 20 mag



Gas structures are abundant at the Galactic center

OSIRIS data cube near Br gamma (2.1661 μm)



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