POLARIZACIJA V ASTRONOMIJI

LJUBLJANA, PRIRODOSLOVNI MUZEJ

2.4.2015

DREJC KOPAČ, LJMU

liverpool JMU

Univerza *v Ljubljani*
Fakulteta za *matematiko in fiziko*

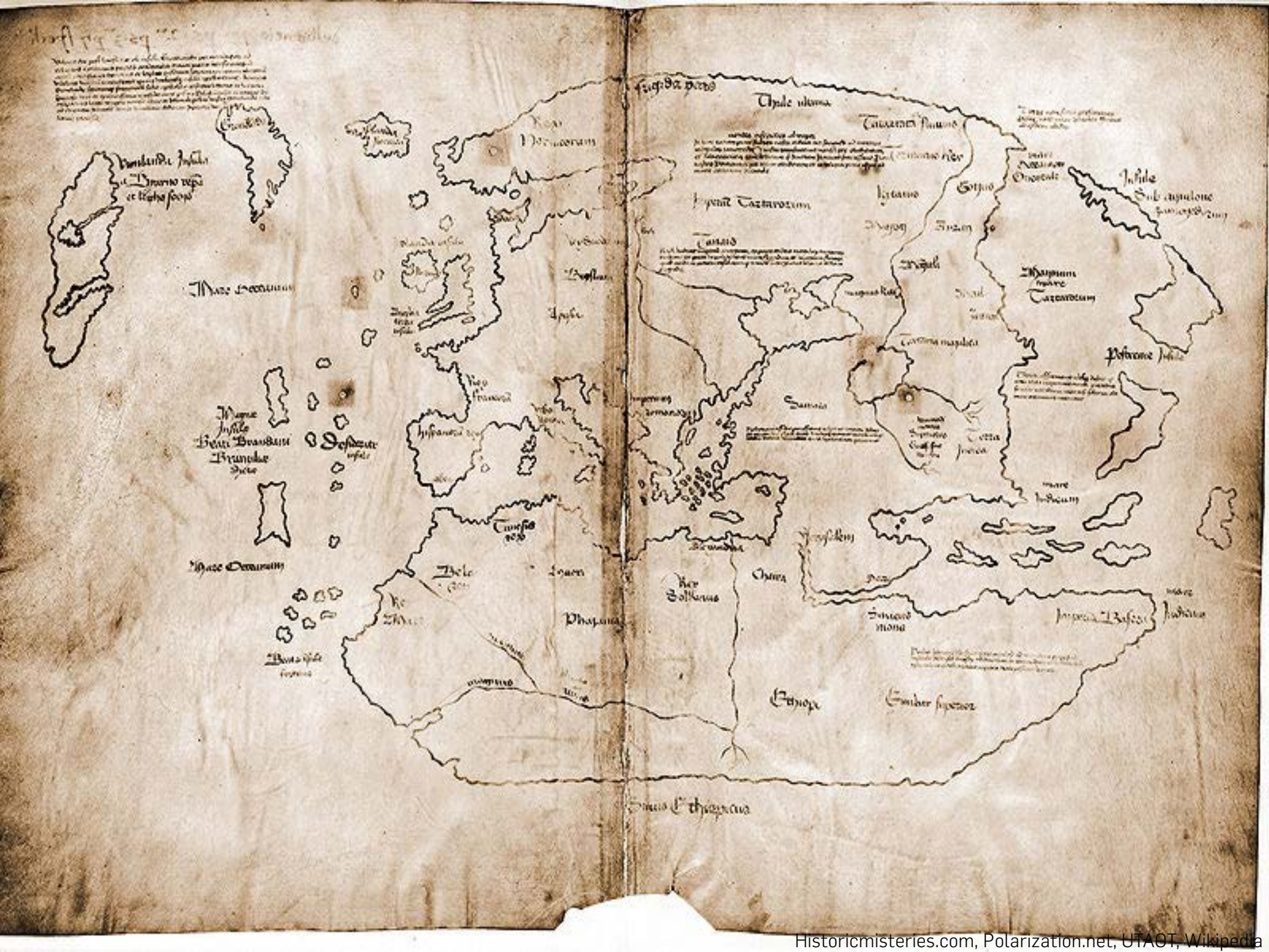
PORTAL v VESOLJE

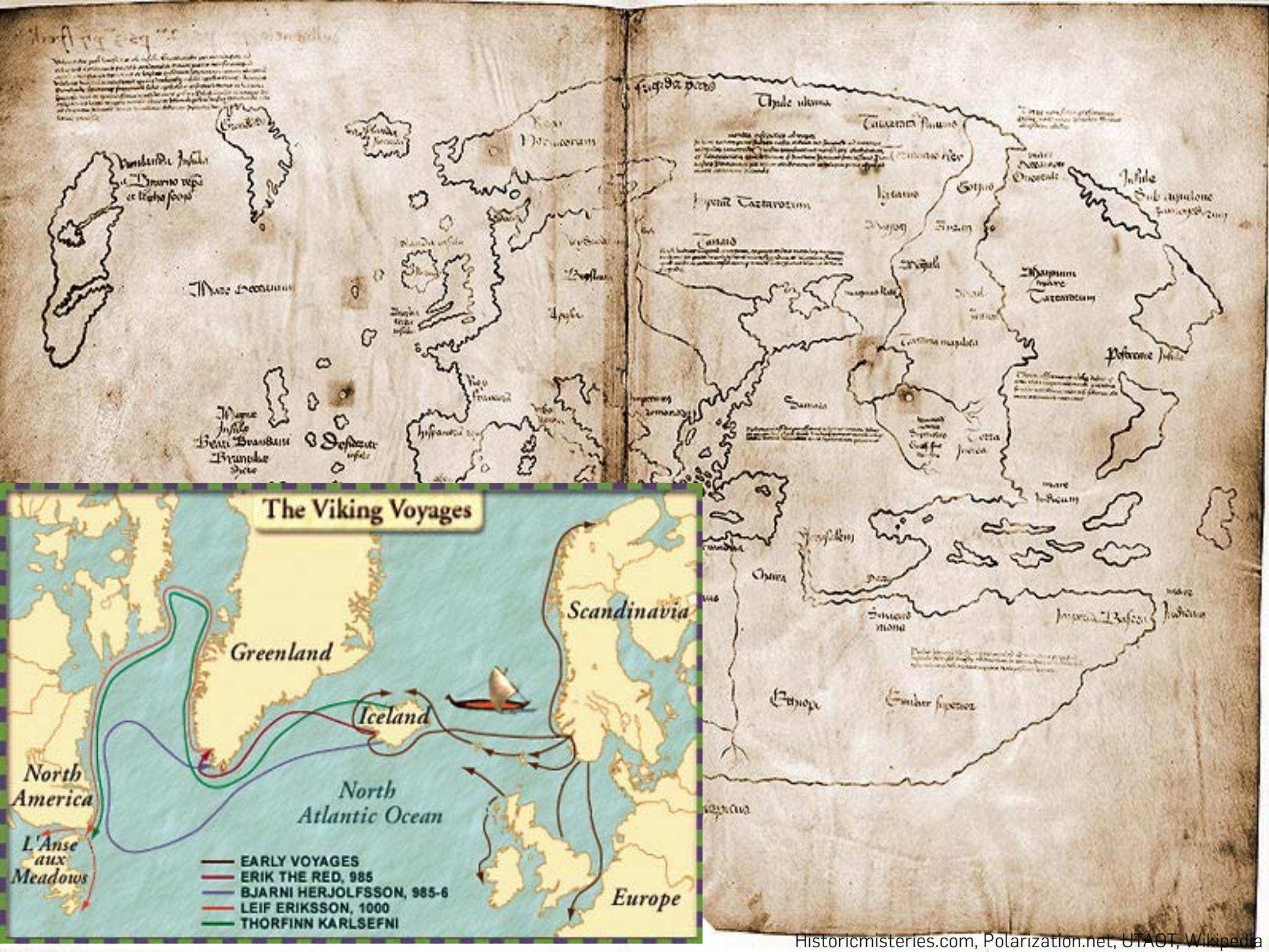
PRIRODOSLOVNI MUZEJ SLOVENIJE

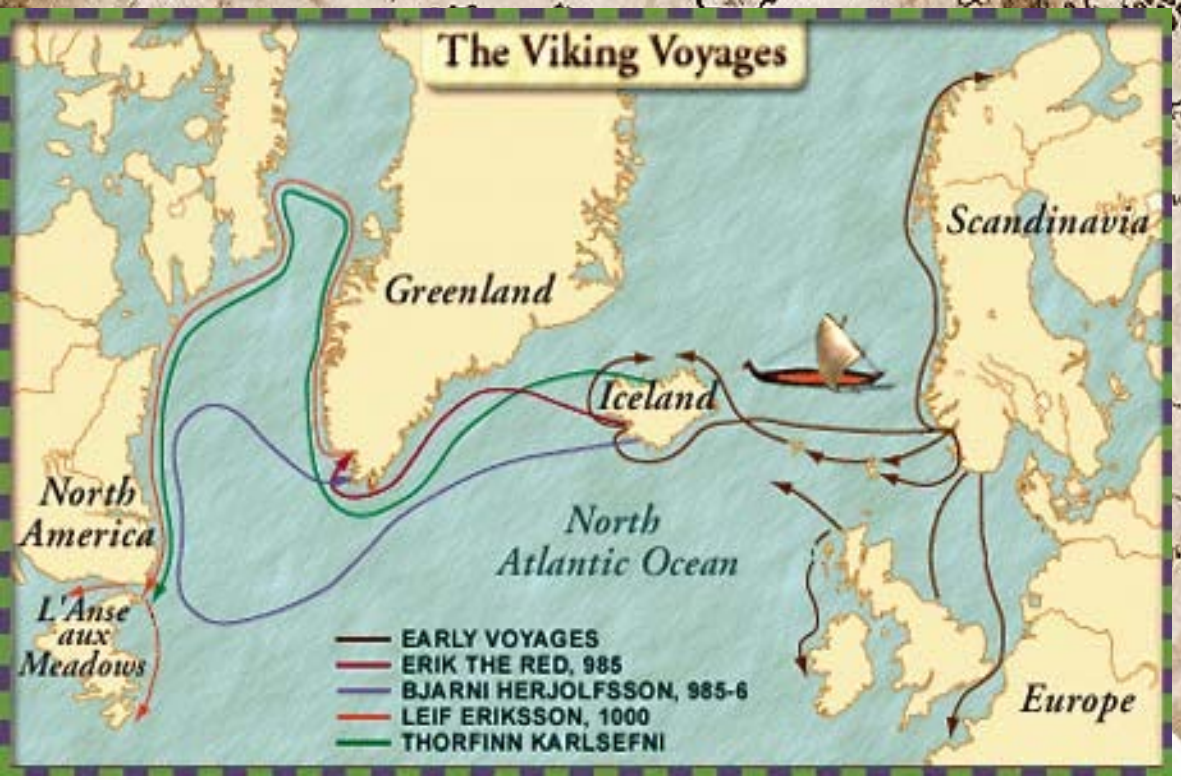
POVZETEK

- VIKINGI
- KONCEPT VRTNE OGRAJE IN KRISTALI
- VODA, PRAH, … IN MAGNETNA POLJA
- EXPO, RINGO, BICEP2
- VIŠJI RAKI (BOGOMOLCARJI)

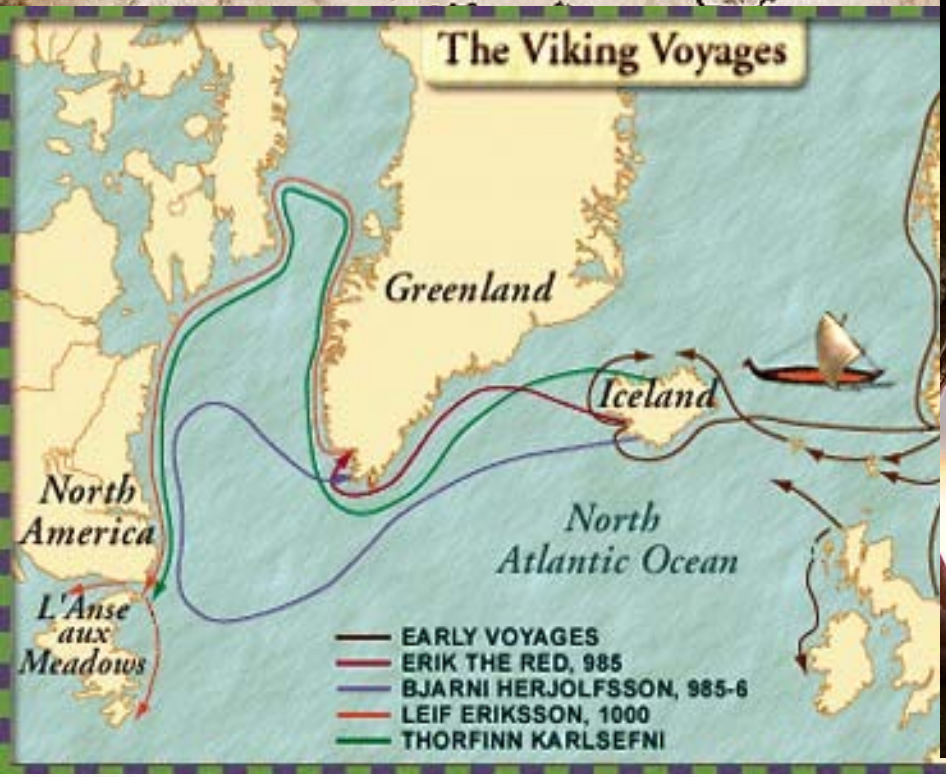
M. Dennis







Historicmisteries.com, Polarization.net, UTAOT, Wikipedia



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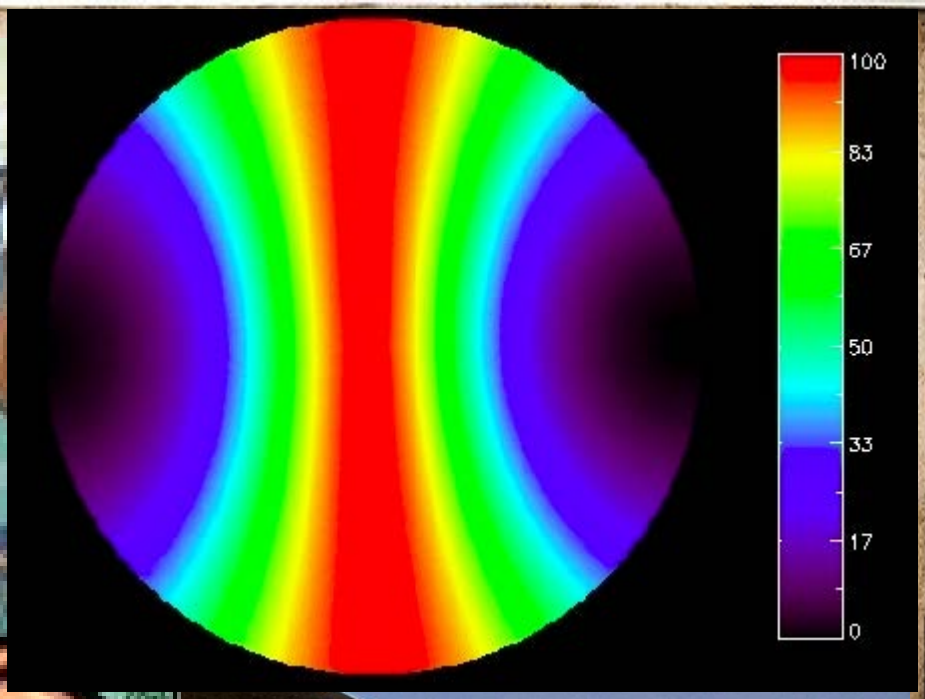

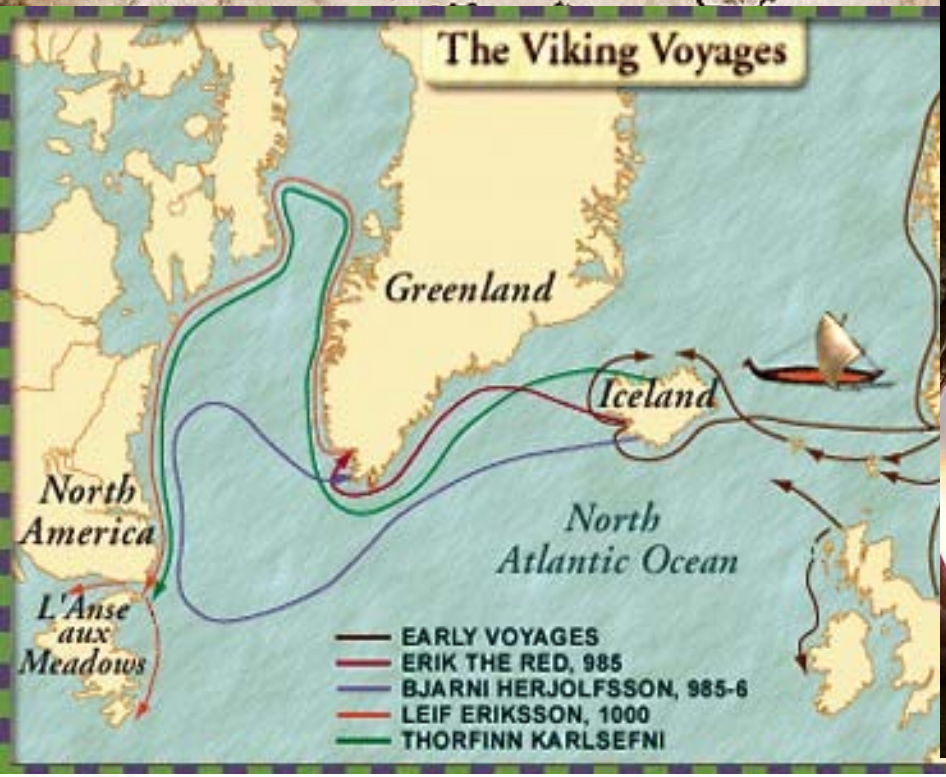

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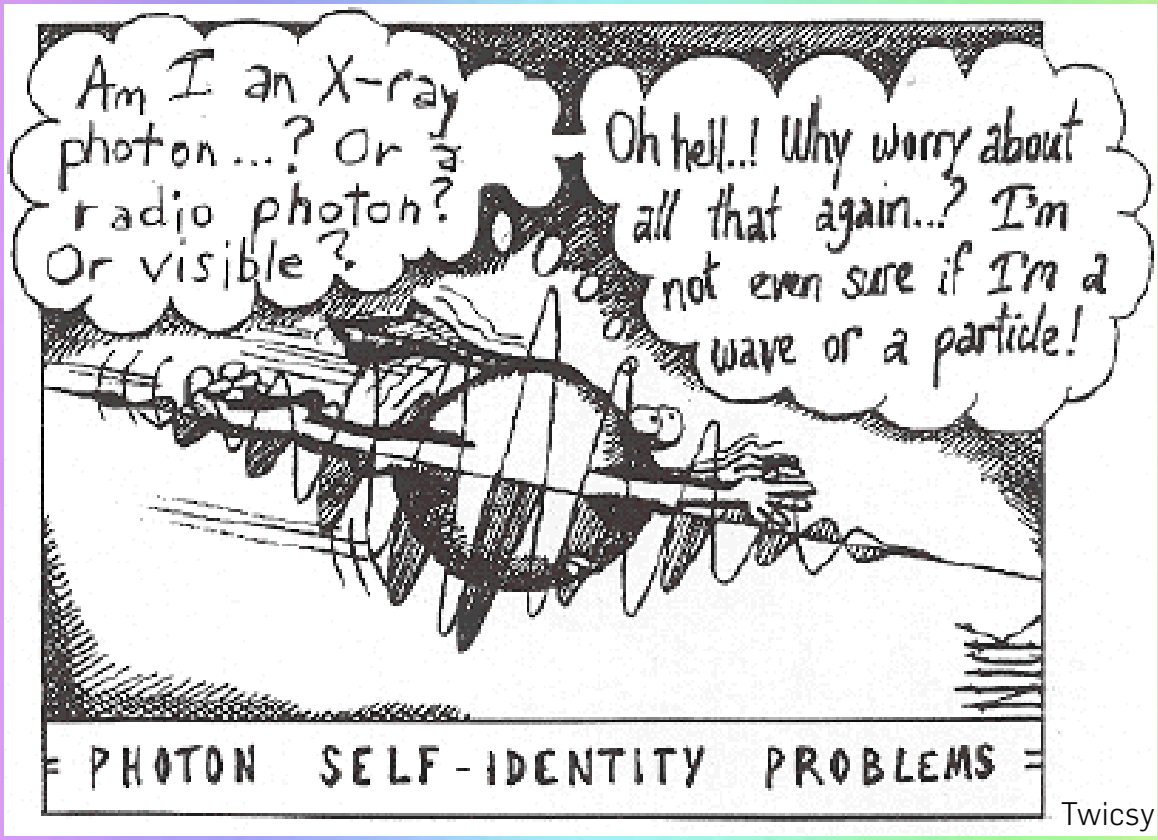
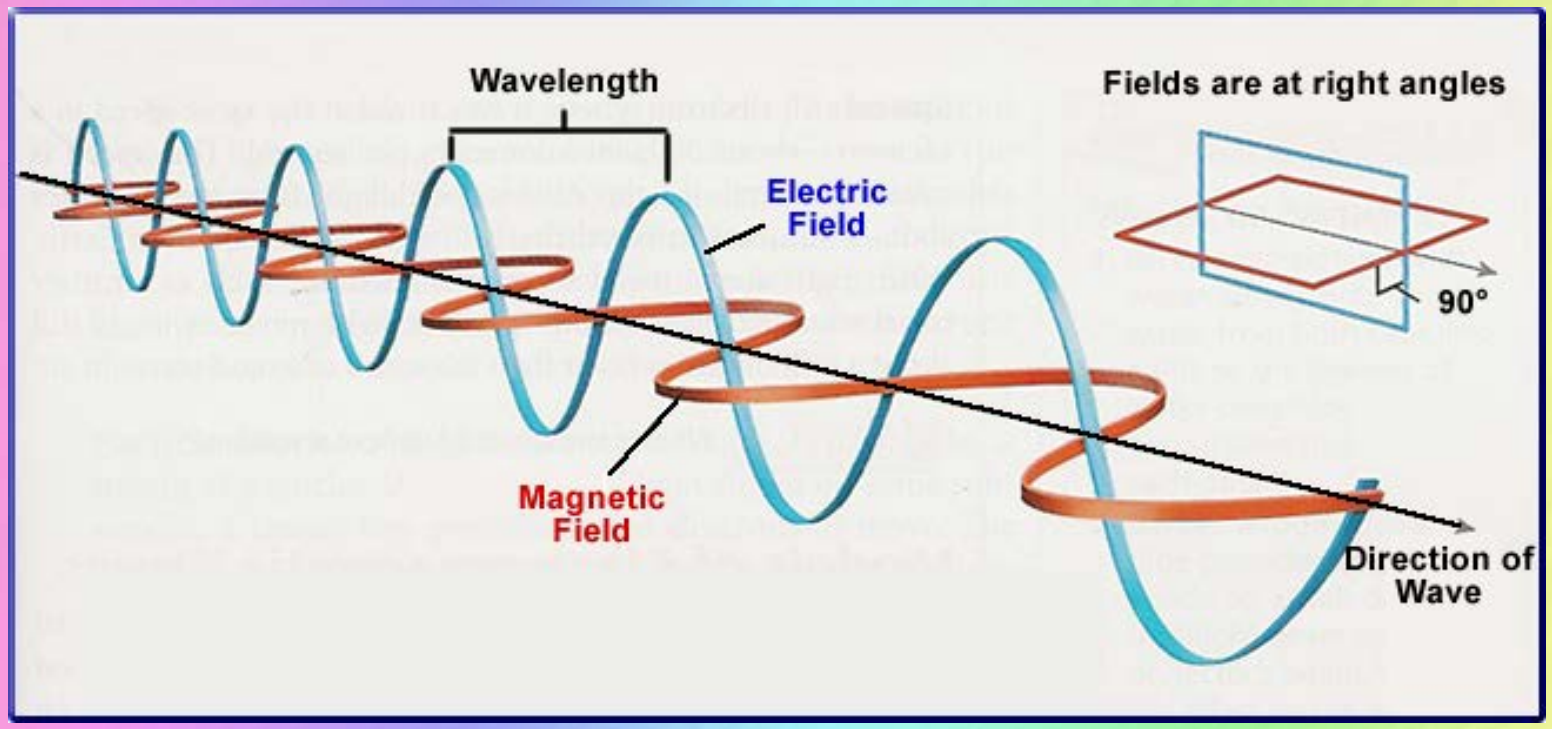
ELEKTROMAGNETNO VALOVANJE



- Konec 1600: Huygens in Newton
- 1925: de Broglie: dualnost delec - val

ELEKTROMAGNETNO VALOVANJE



Wikipedia

- Valovna dolžina
- Jakost
- Orientacija

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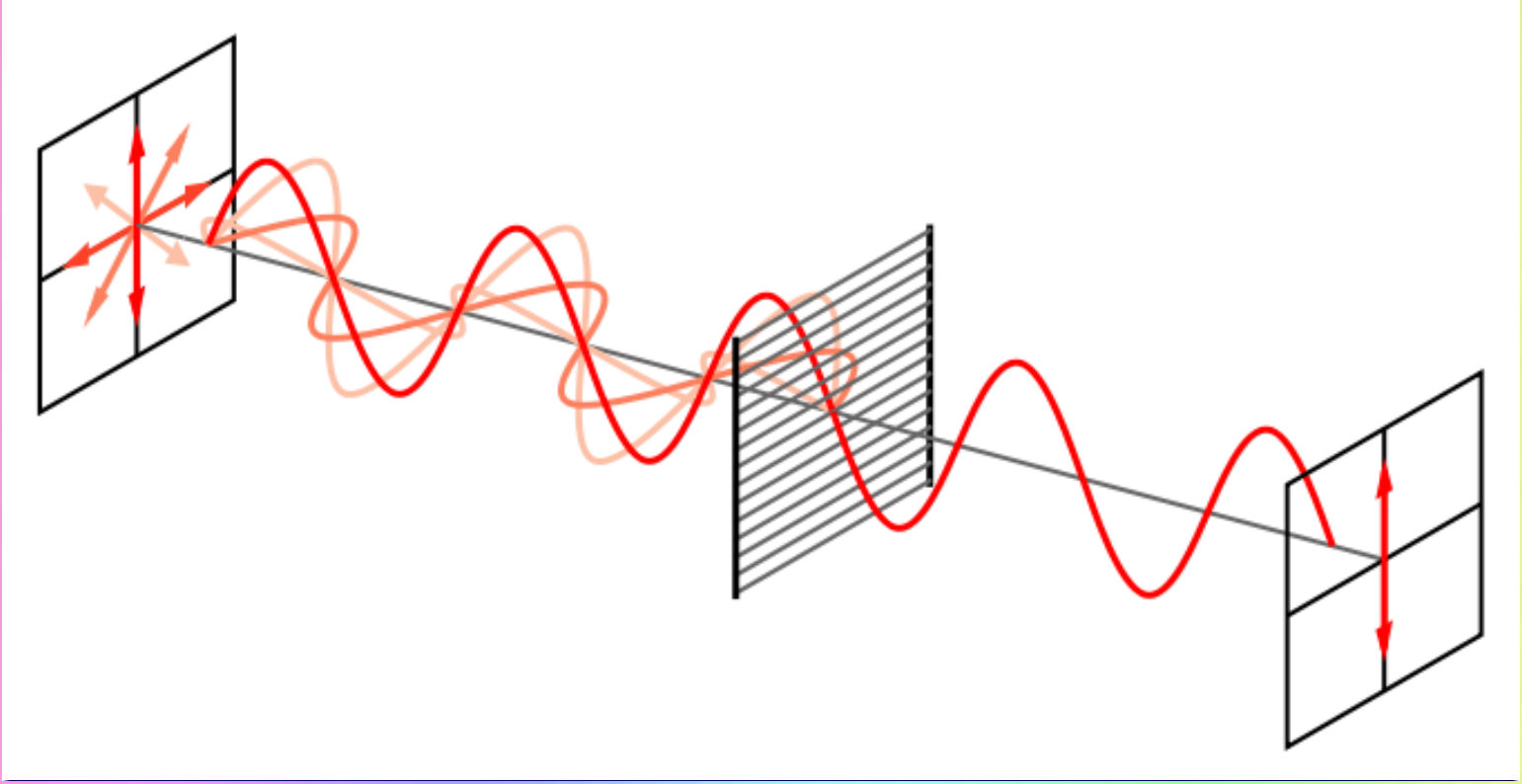

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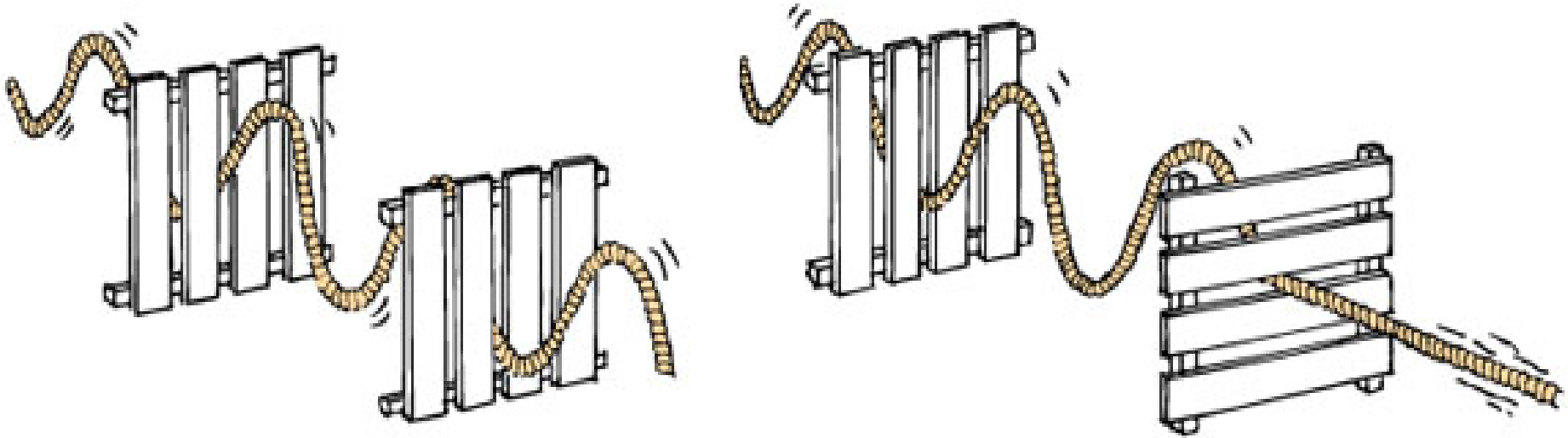
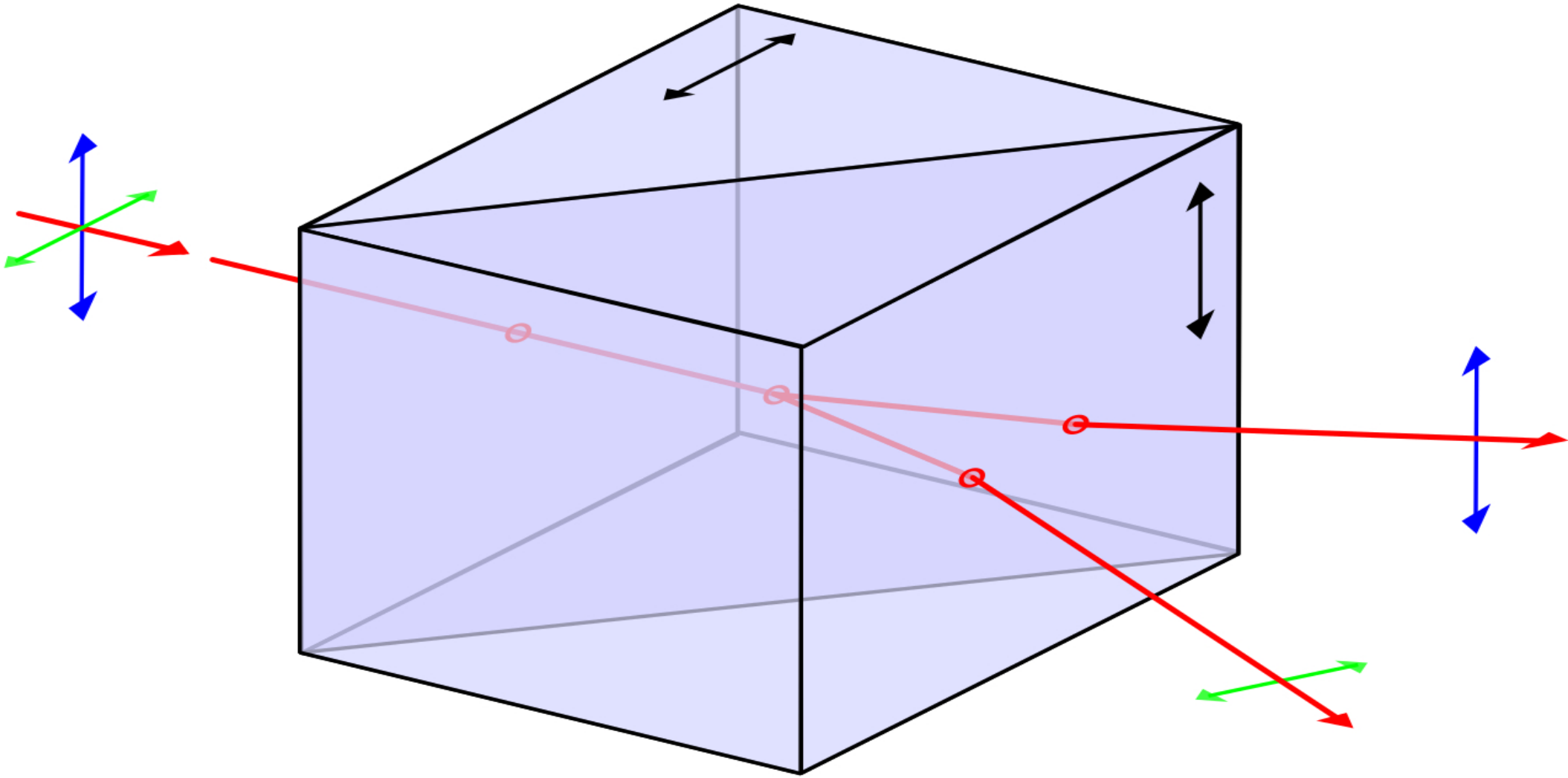
EKSPERIMENT Z VRTNO OGRAJO



KRISTALI



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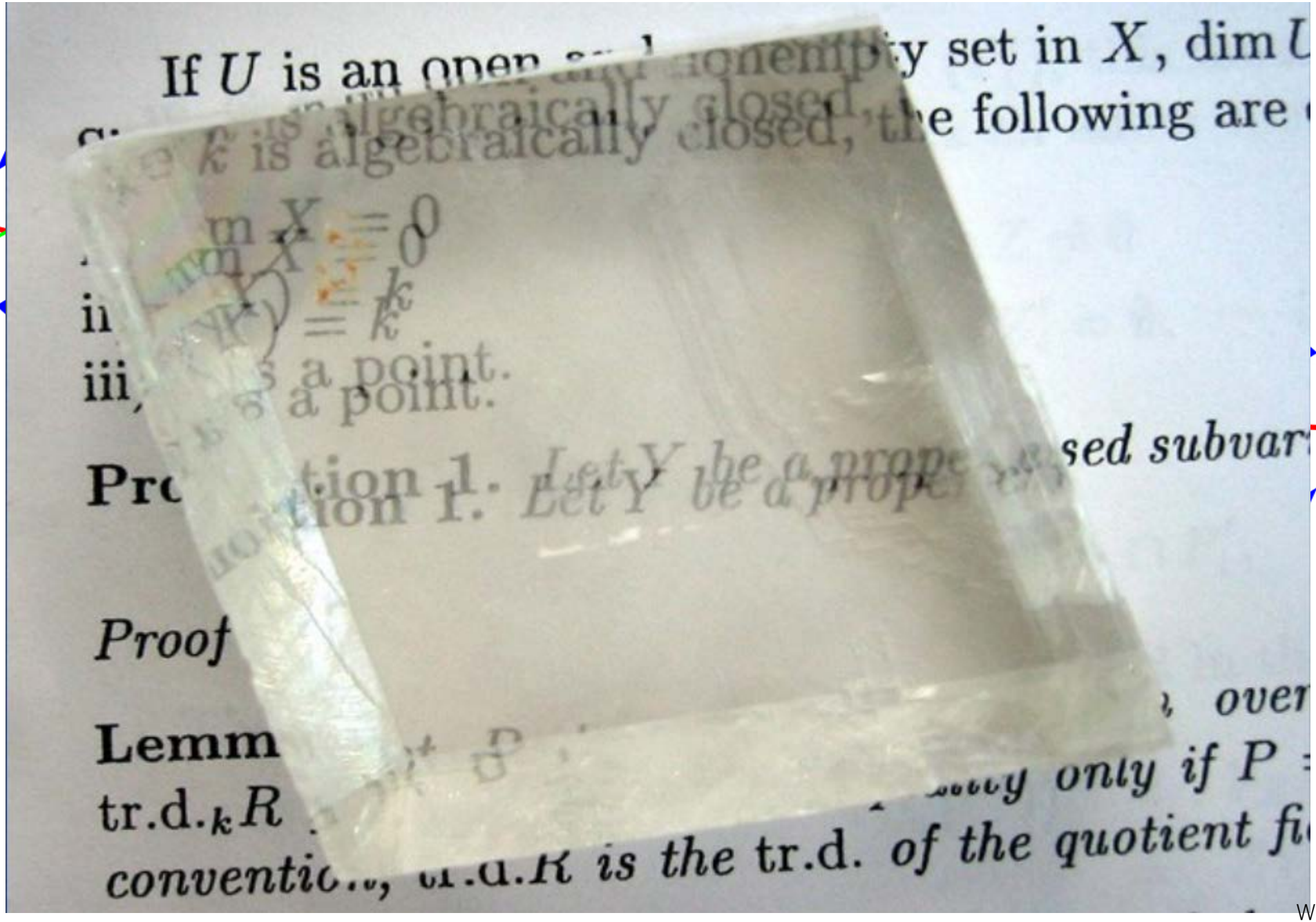
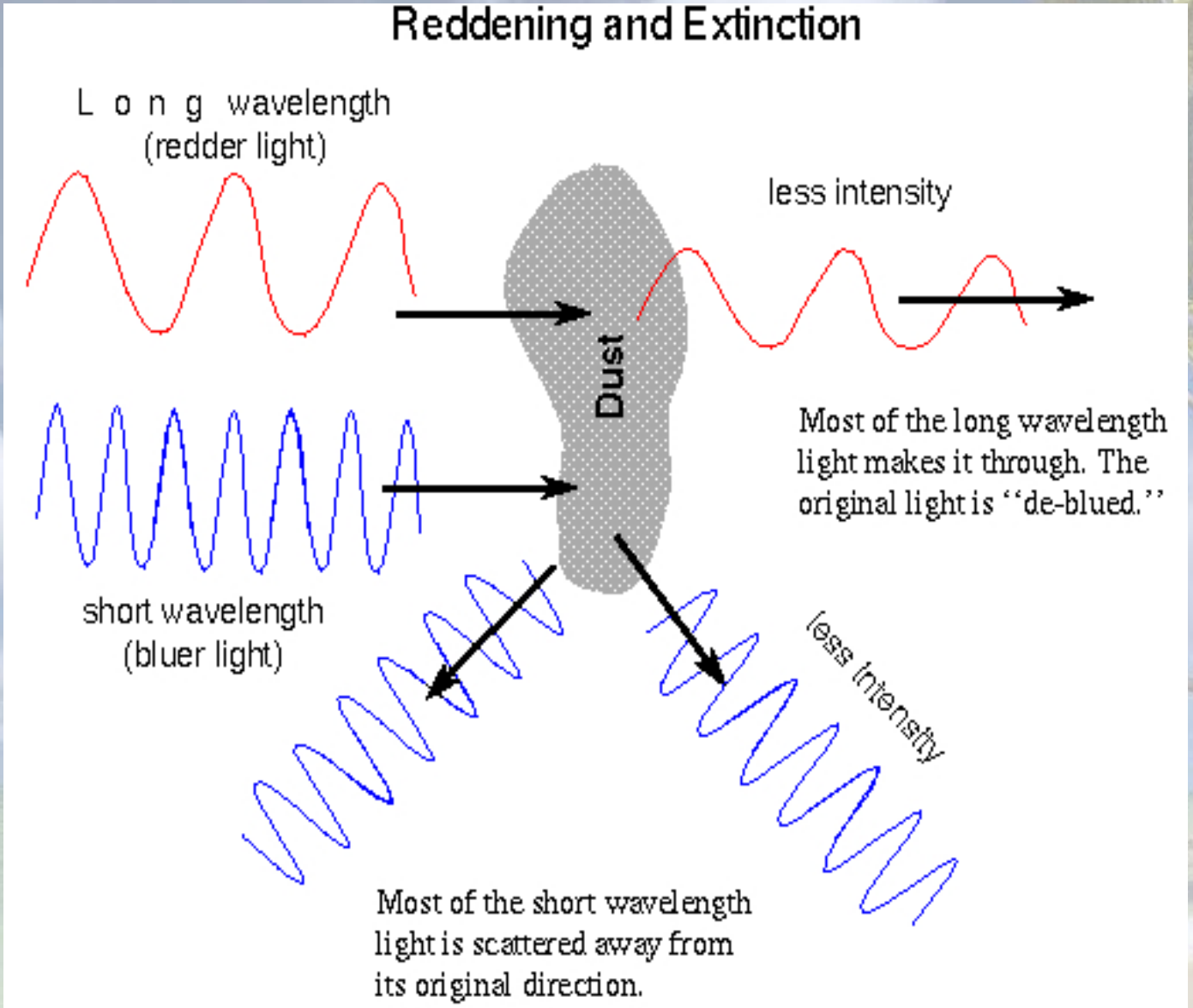


Wikipedia

SIPANJE IN ODBOJ

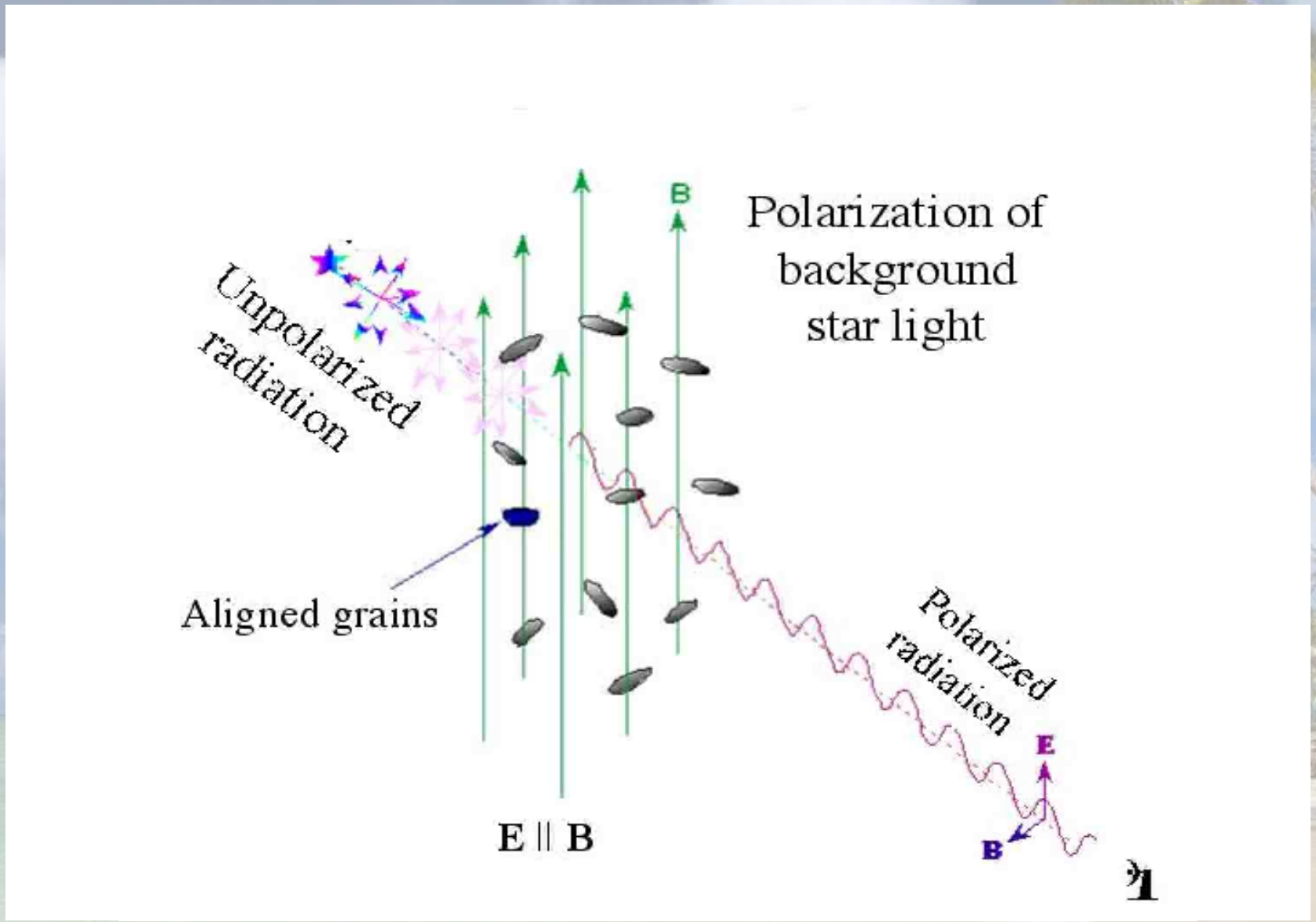
SIPANJE IN ODBOJ

ODBOJ IN SIPANJE



- Rayleigh-jevo sipanje

ODBOJ IN SIPANJE



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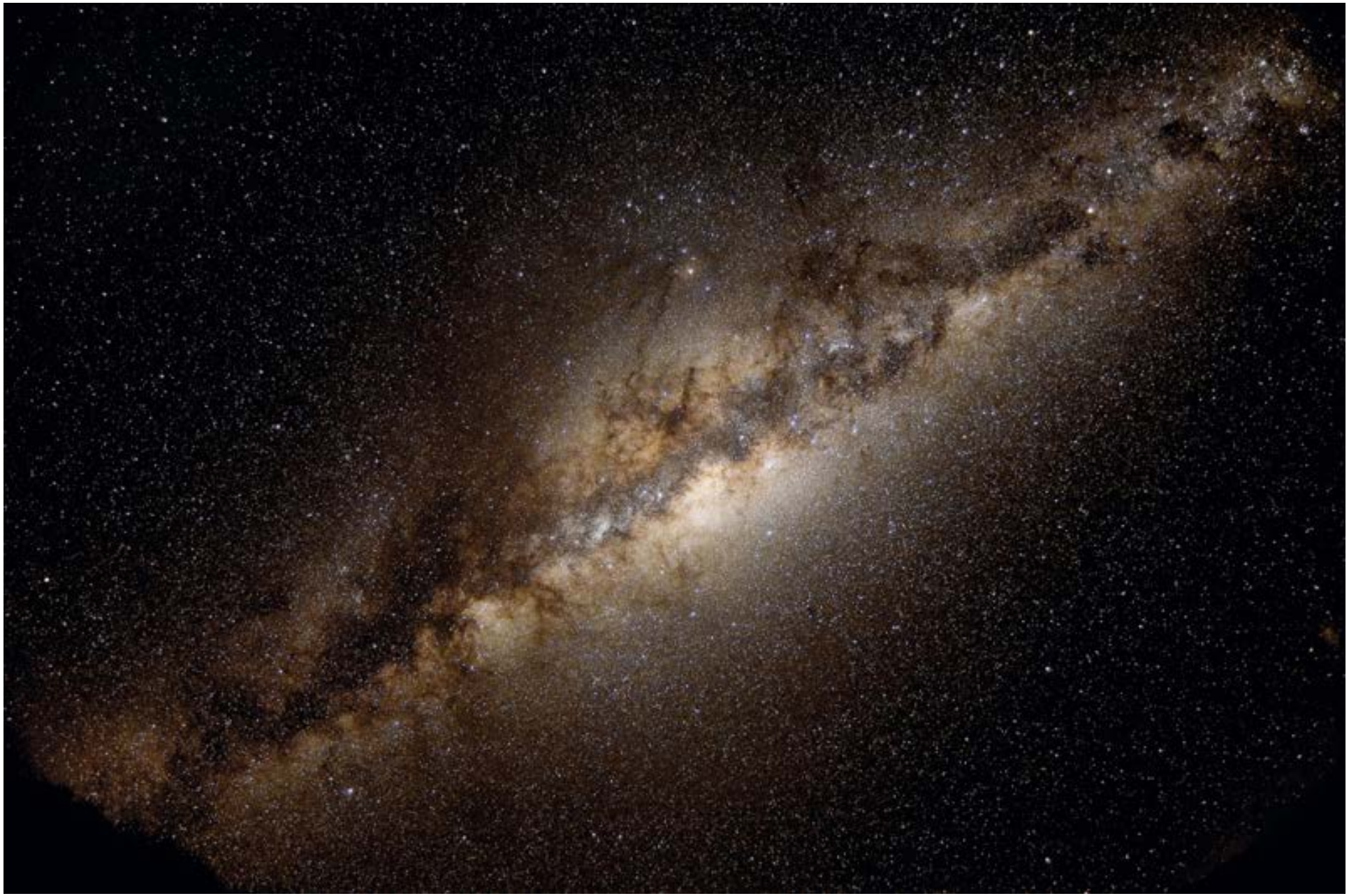
PRAH IN ASTRONOMIJA



NASA

PRAH IN ASTRONOMIJA

NASA

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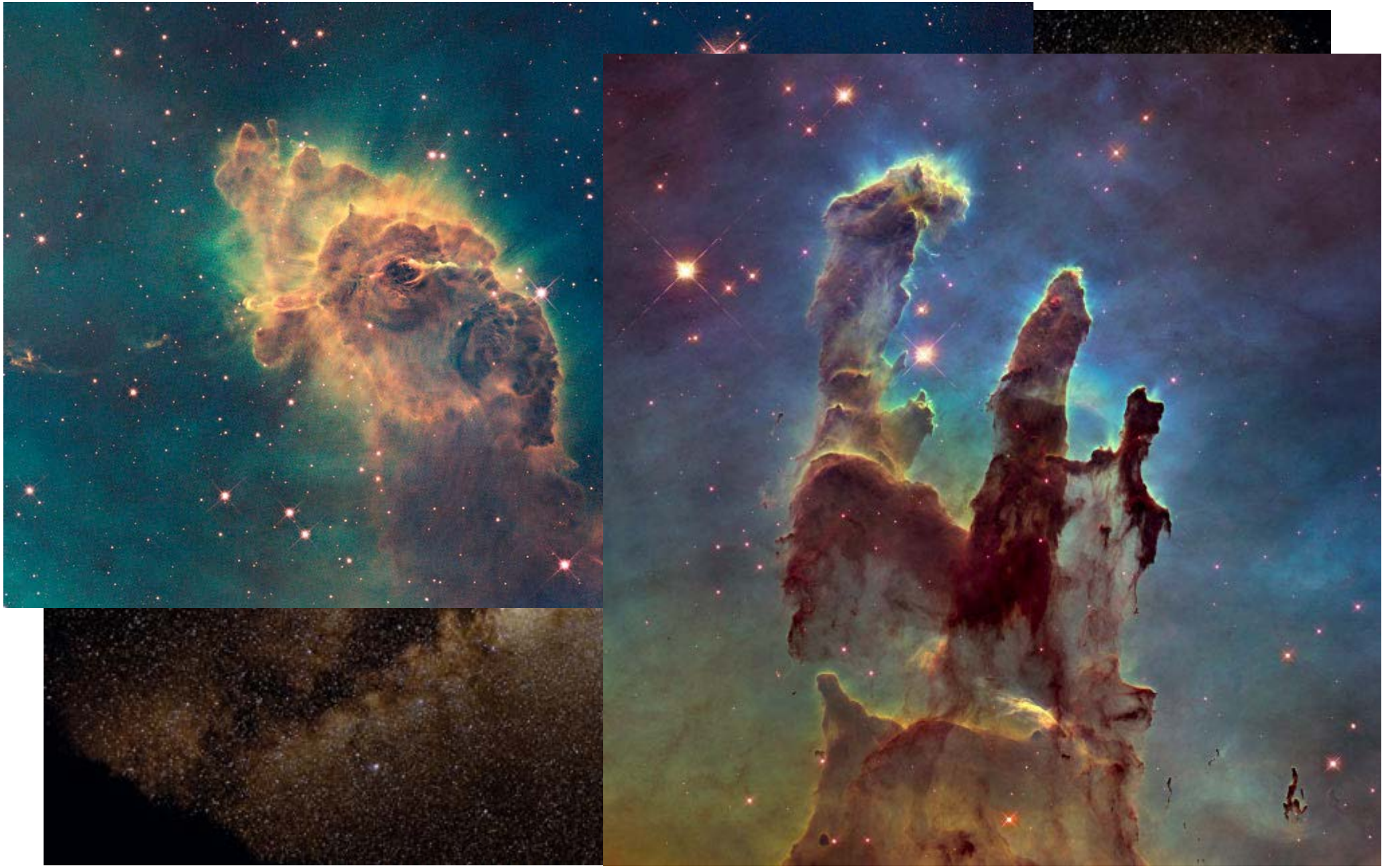

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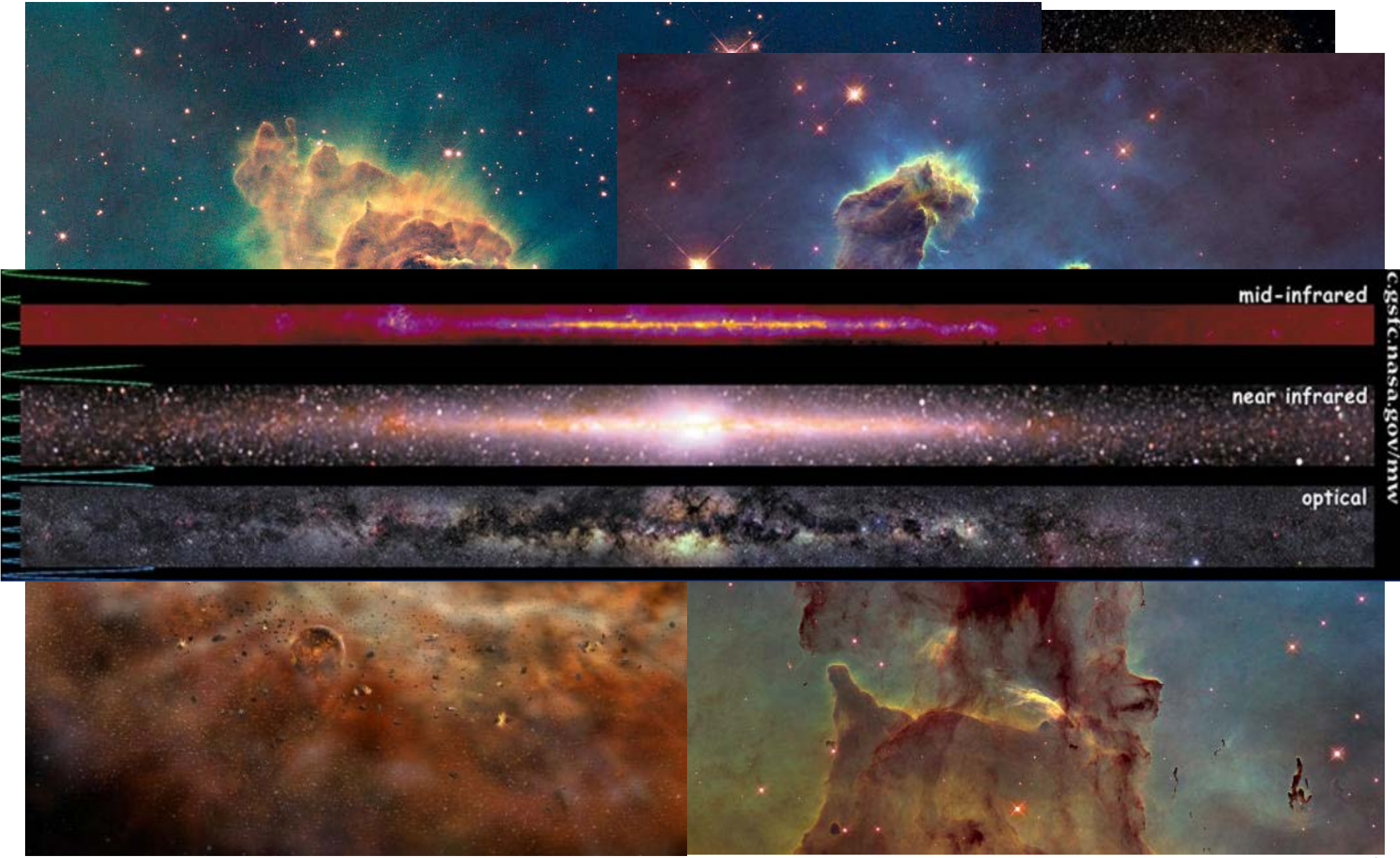
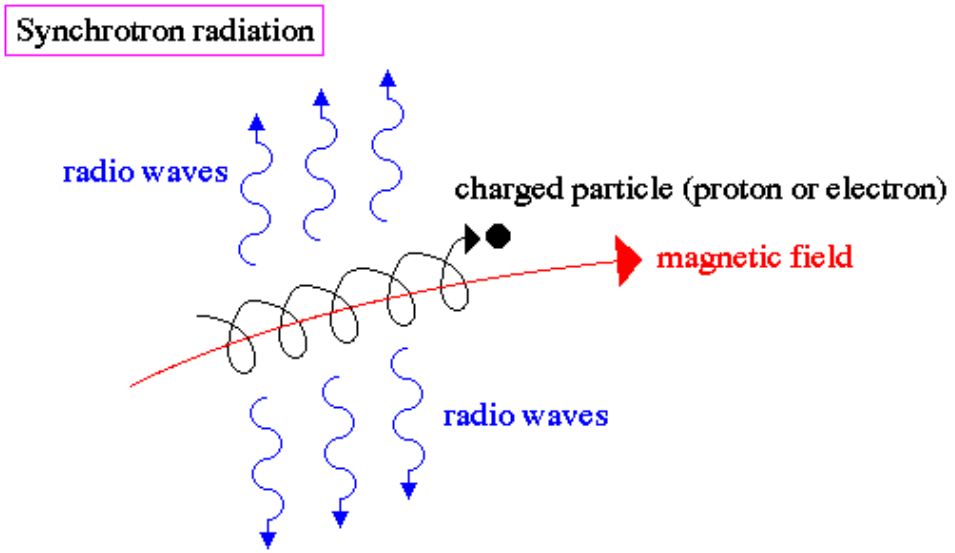
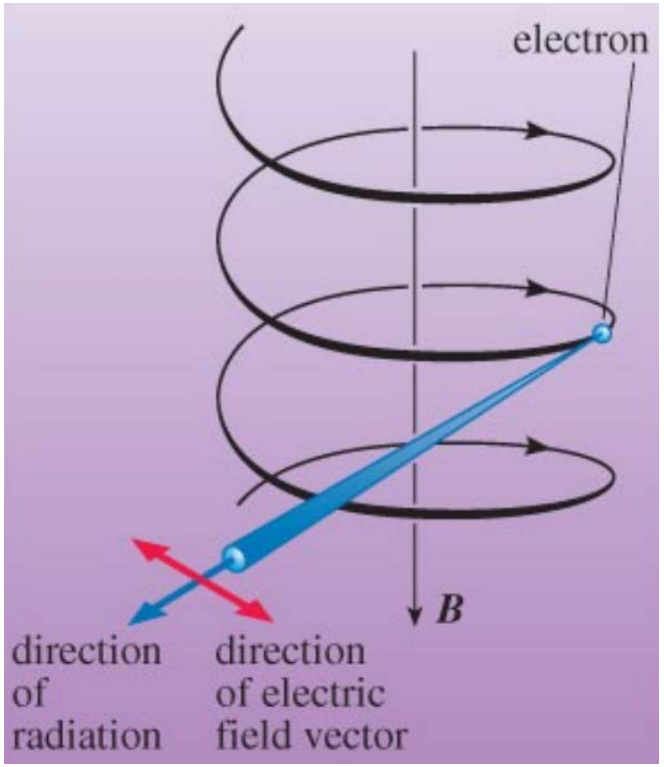


NASA

MAGNETNA POLJA IN SINHROTRONSKO SEVANJE



synchrontron radiation occurs when a charged particle encounters a strong magnetic field – the particle is accelerated along a spiral path following the magnetic field and emitting radio waves in the process – the result is a distinct radio signature that reveals the strength of the magnetic field



- Plazma: prosti elektroni
- Magnetno polje "pospeši" elektrone, ki sevajo
- Sevanje je polarizirano

NASA

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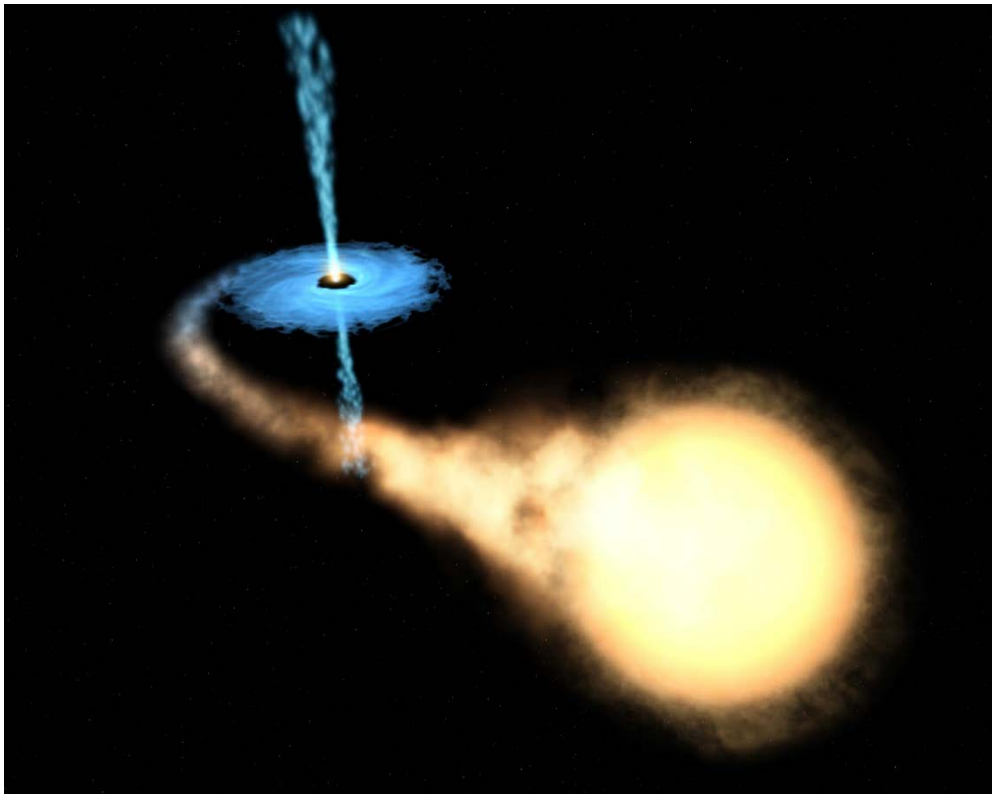

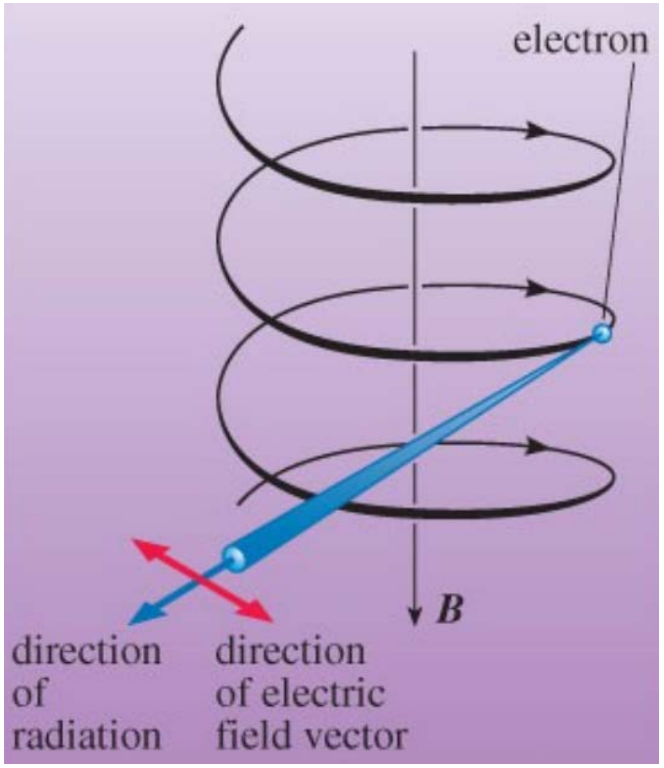

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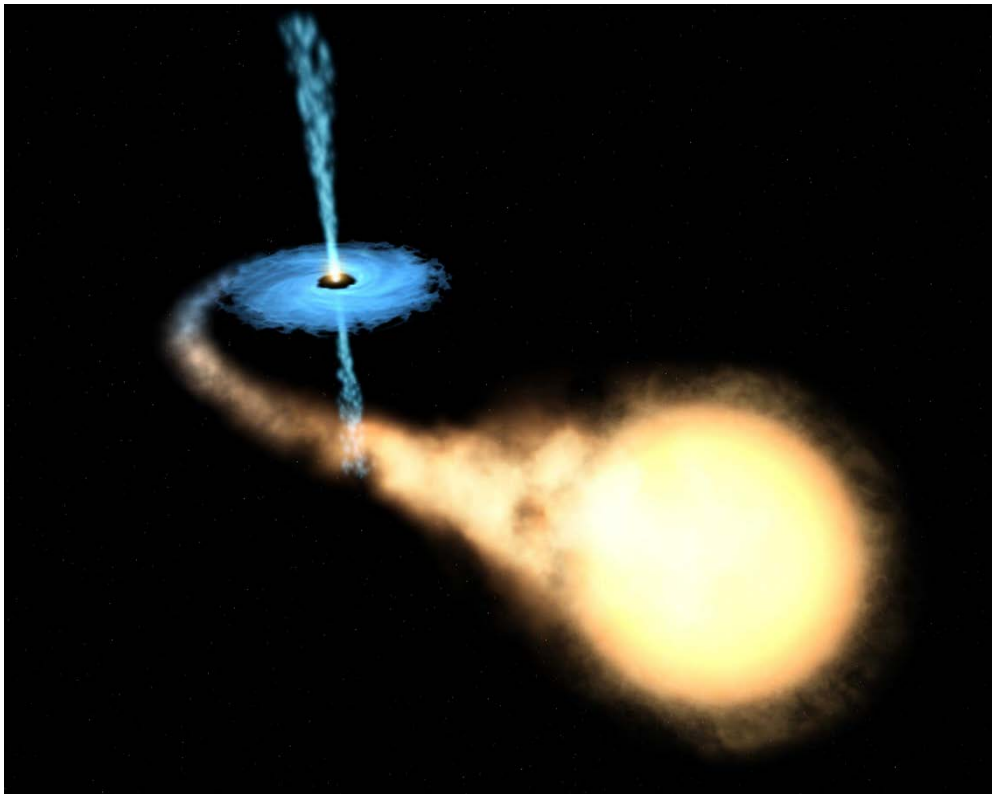

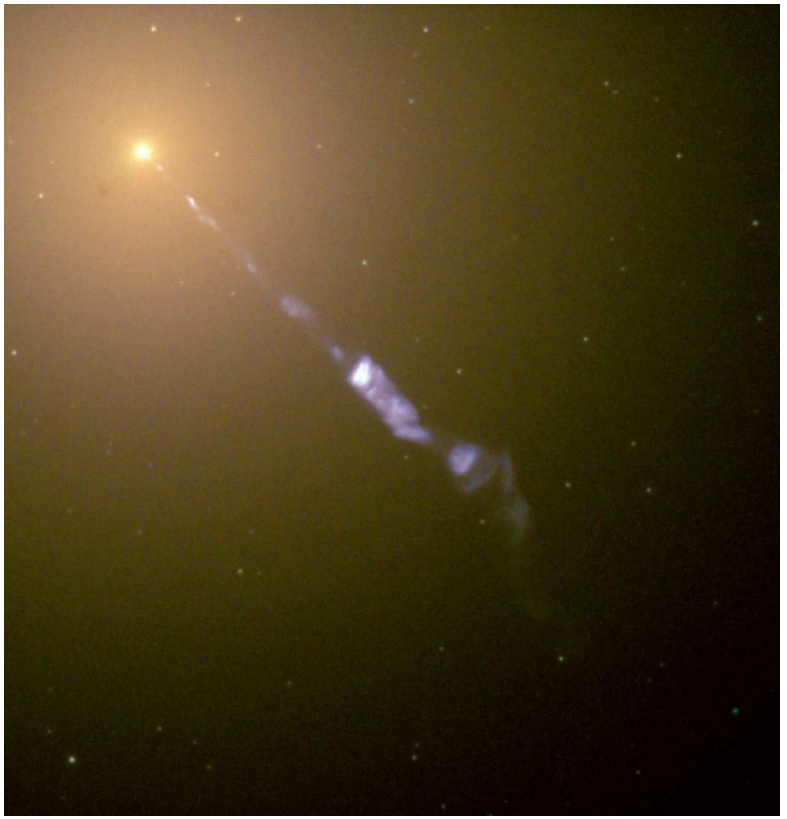

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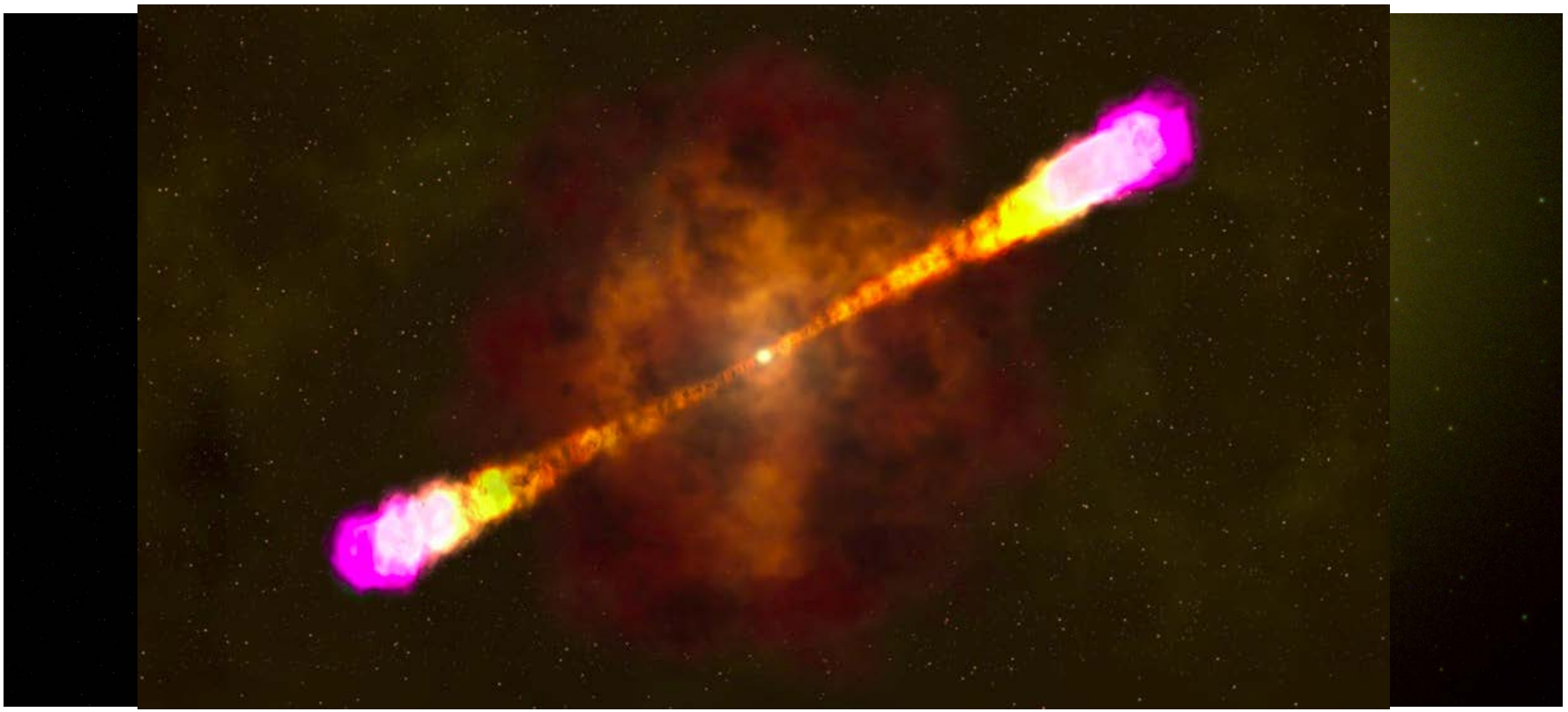

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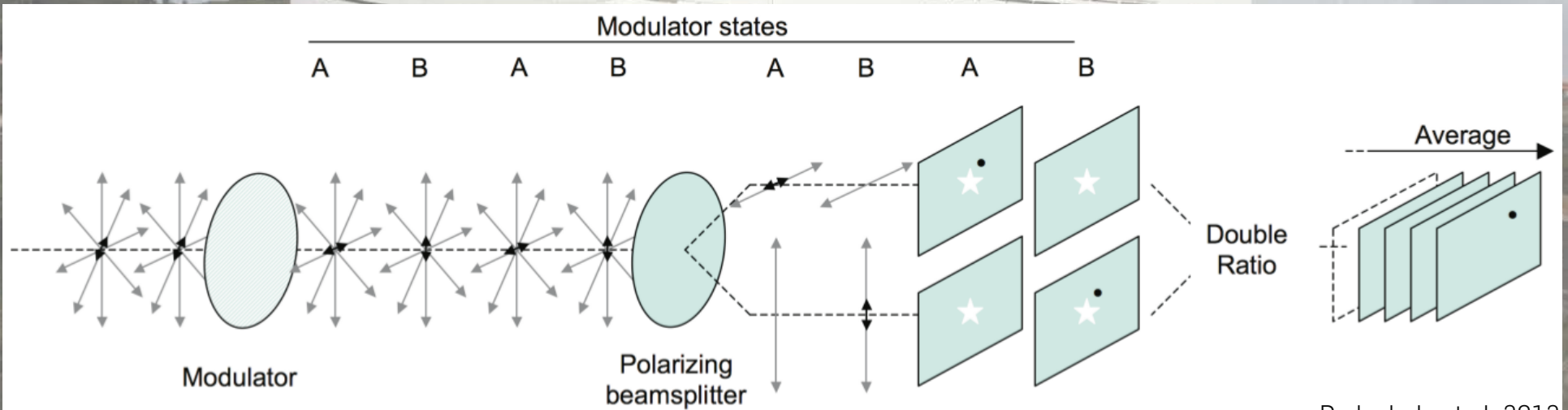
NASA

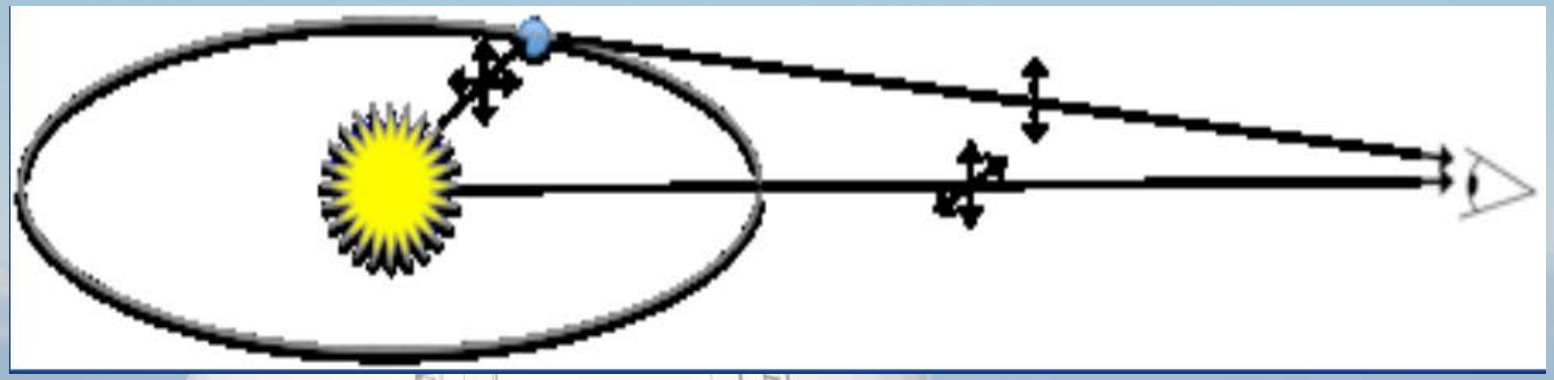
ExPo: The Extreme Polarimeter

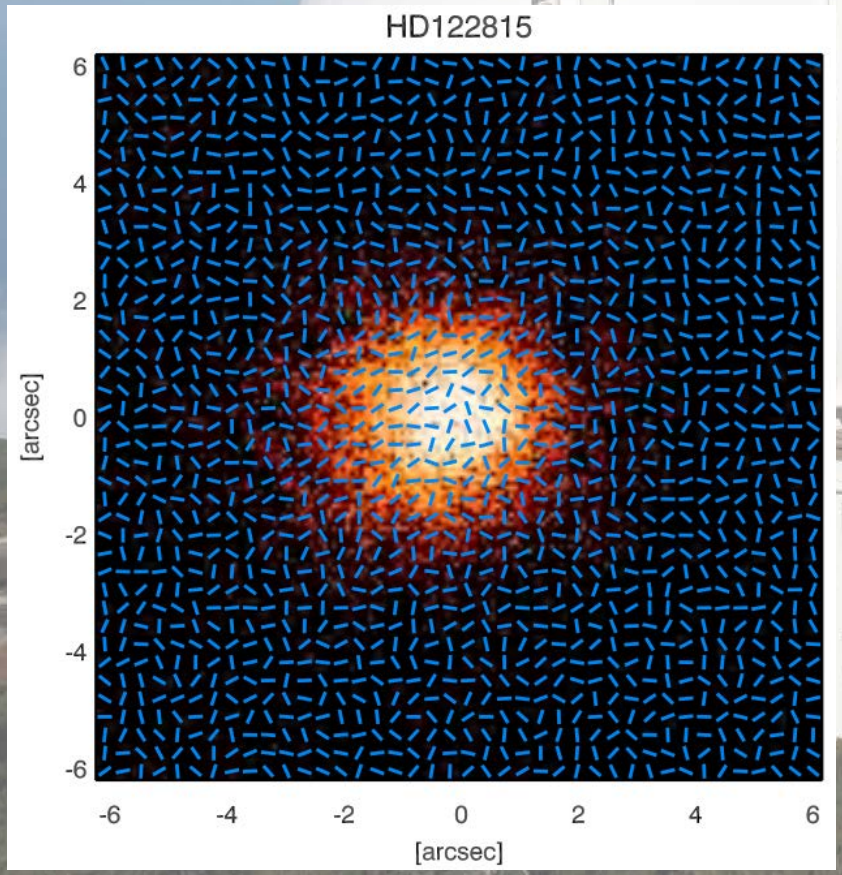
- Polarimeter na 4.2-m teleskopu William Herschel, La Palma
- Ločitev nepolarizirane in polarizirane svetlobe
- Polarimetrija obzvezdnega prahu
- Študija eksoplanetov/eksoplanetarnih sistemov, ter njihovih atmosfer
- Izredno hiter zajem podatkov (35 fps) pomaga pri odstranjevanju atmosferskih napak

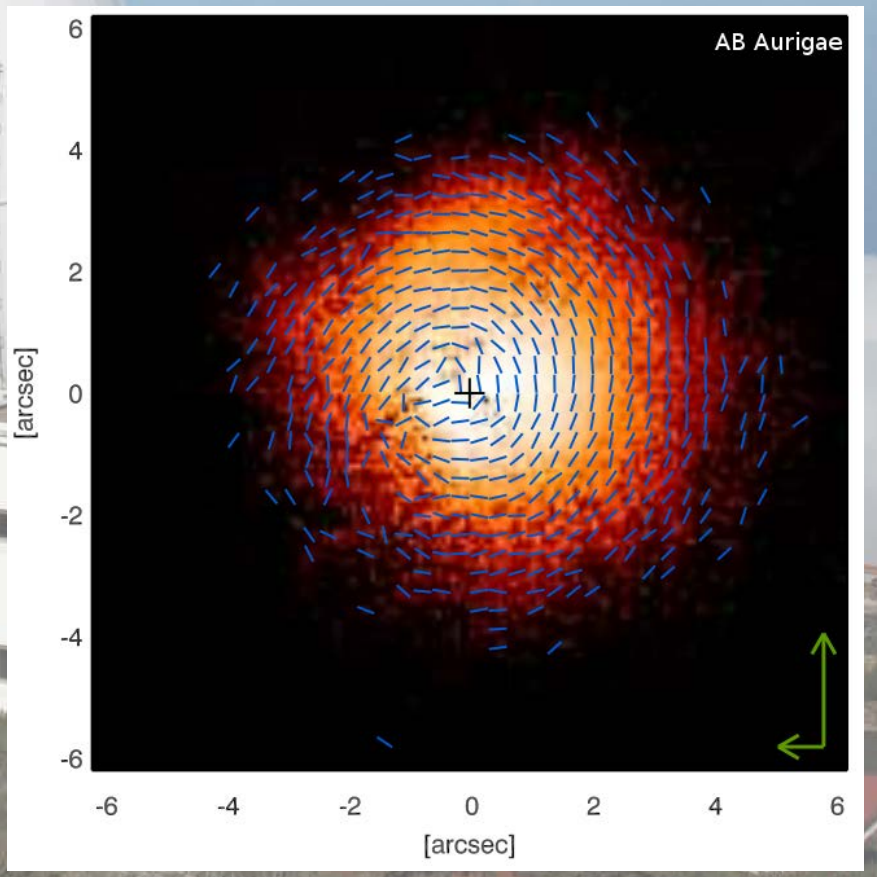


Rodenhuls et al. 2012

ExPo: The Extreme Polarimeter





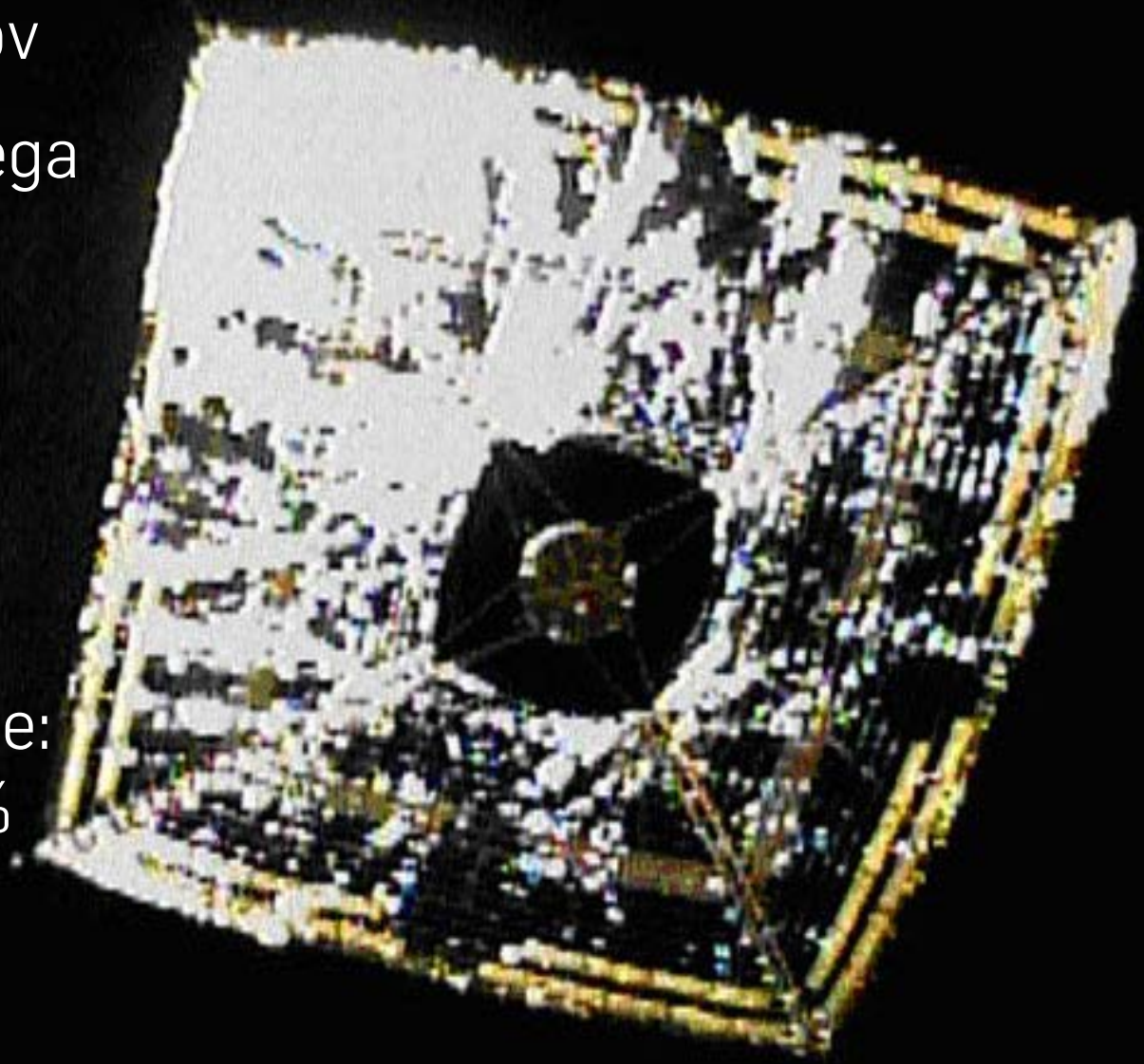


- Natančnost meritve polarizacije: 1e-4

Rodenhuls et al. 2012

GAP (IKAROS)

- Polarimeter gama fotonov
- Anizotropija Comptonovega sipanja
- Uporaben za merjenje polarizacije izbruhov sevanja gama
- Za 3 izbruhe izmeril zelo visoko stopnjo polarizacije: (27+-11)% do (70+-22)%
- Nenatančnost
- Problematična kalibracija

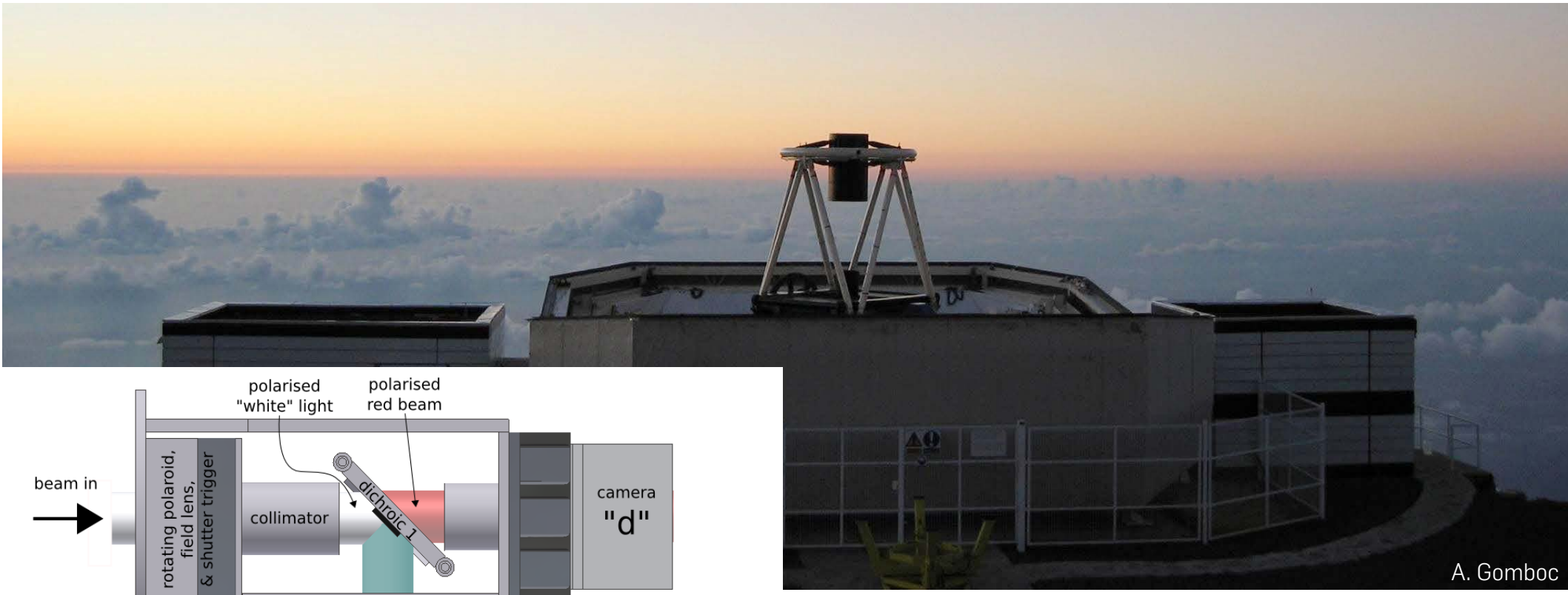


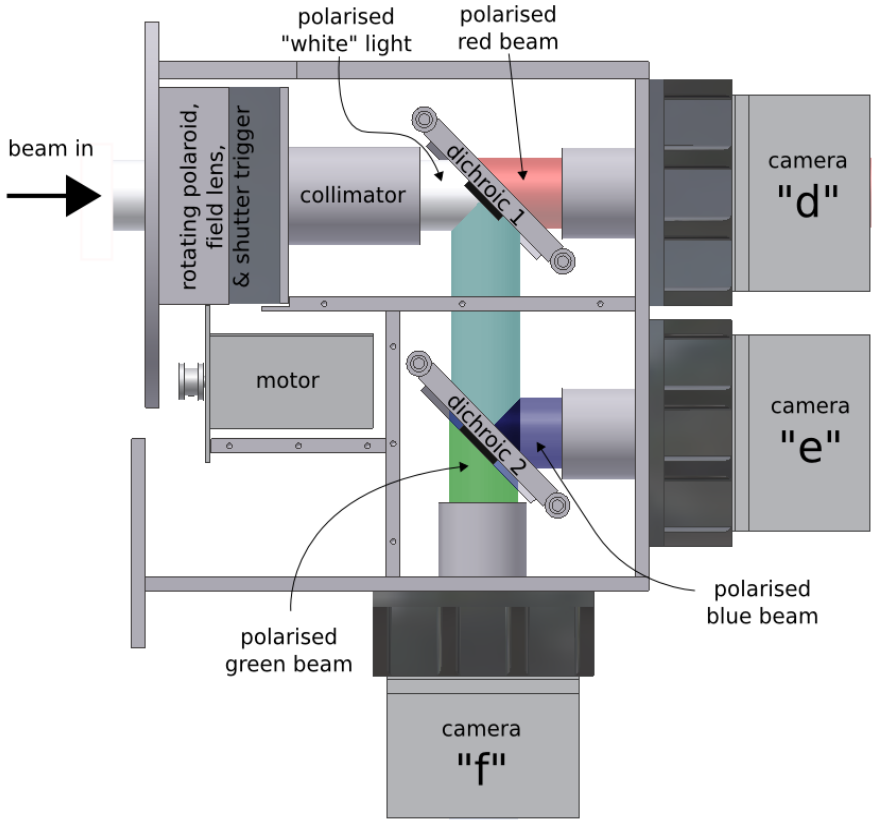
Yonetoku et al., 2010

RINGO/2/3 (Liverpool Telescope)

Arnold et al. 2012

RINGO/2/3 (Liverpool Telescope)



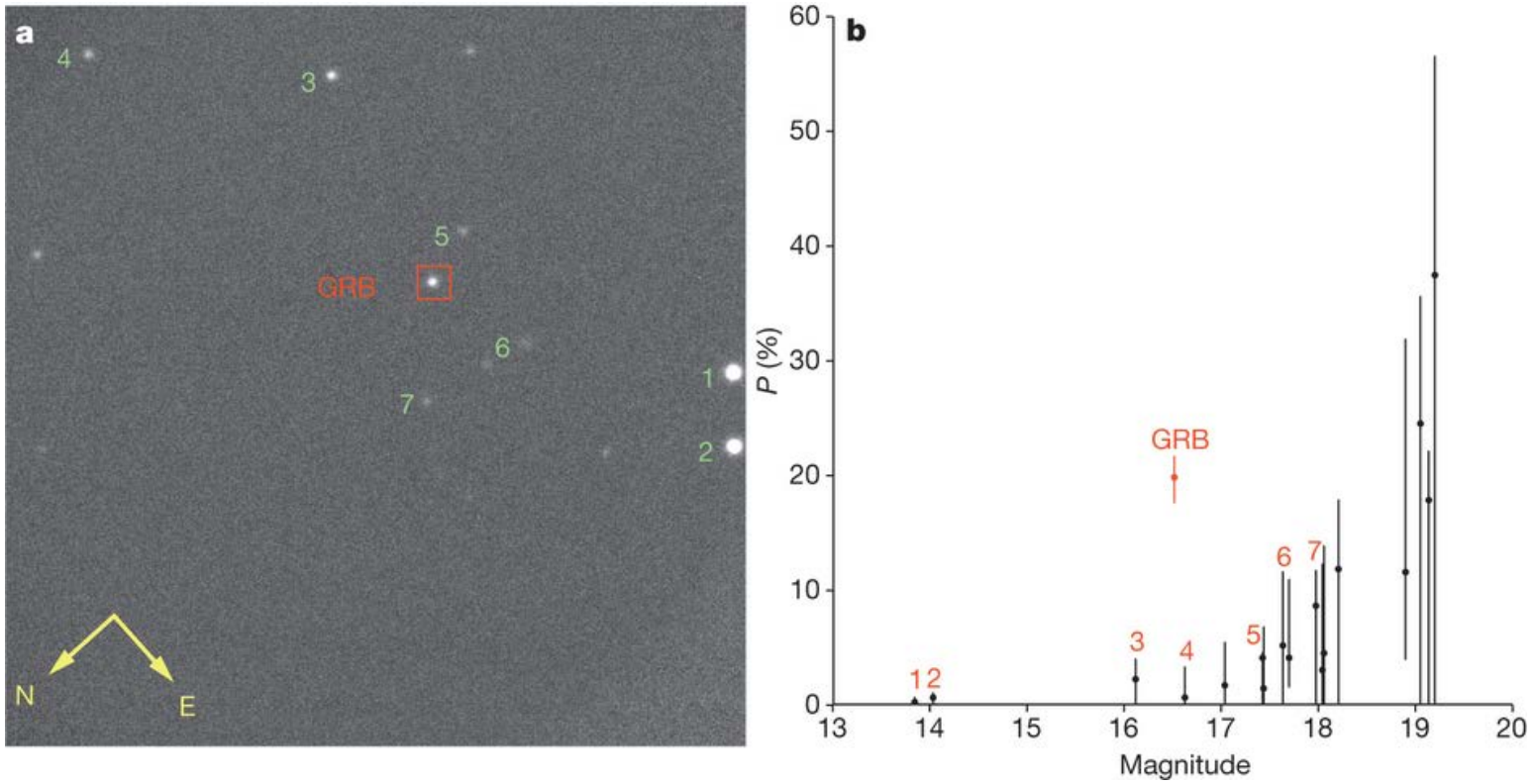


- 8 fps
- Limitna magnituda: 17 mag
- 3 barve
- Uporaben tudi za fotometrijo
- Natančnost polarizacije: 1%

Arnold et al. 2012

RINGO/2/3 (Liverpool Telescope)

- Primarno za izbruhe sevanja gama (GRB)
- Tudi za kvazarje/blazarje, zvezde, rentgenske dvojnice, ipd.
- GRB 120308A: P = (28 +- 4) %



Mundell et al. 2013

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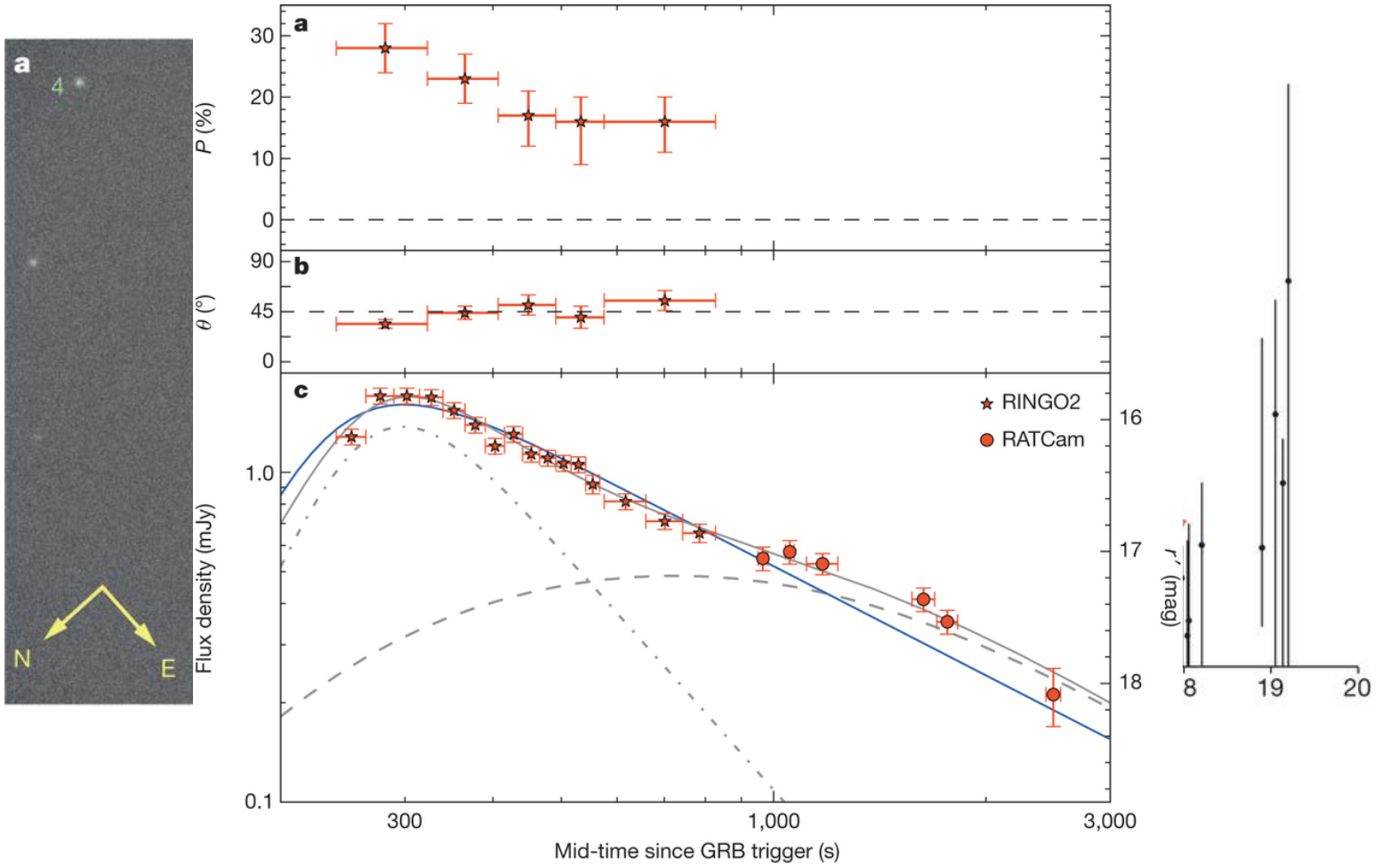

Mundell et al. 2013

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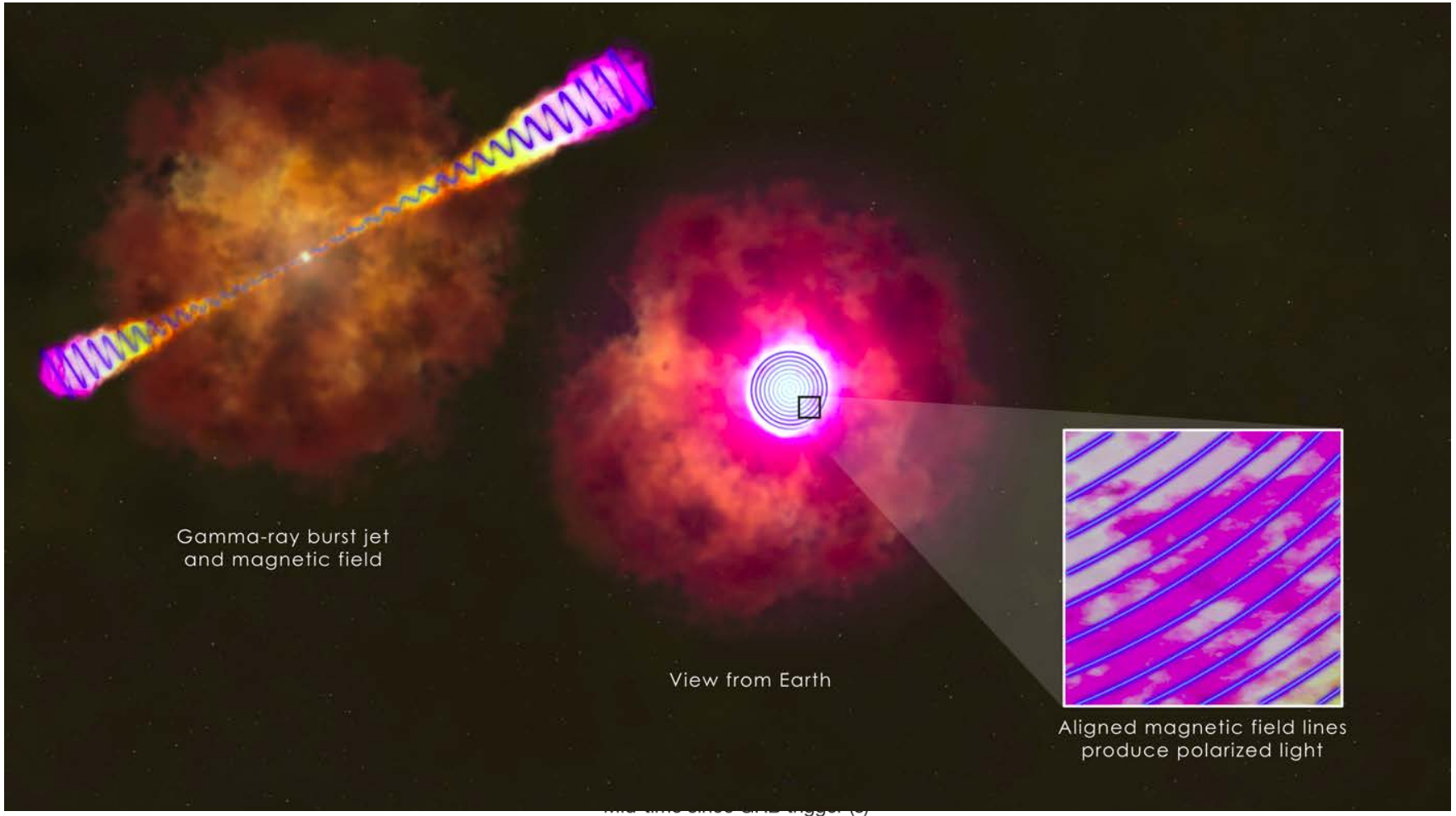
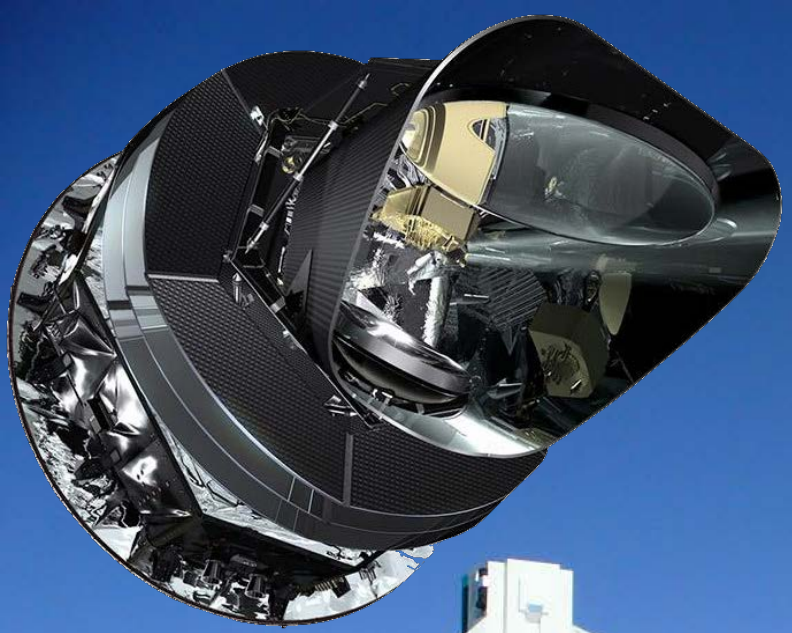
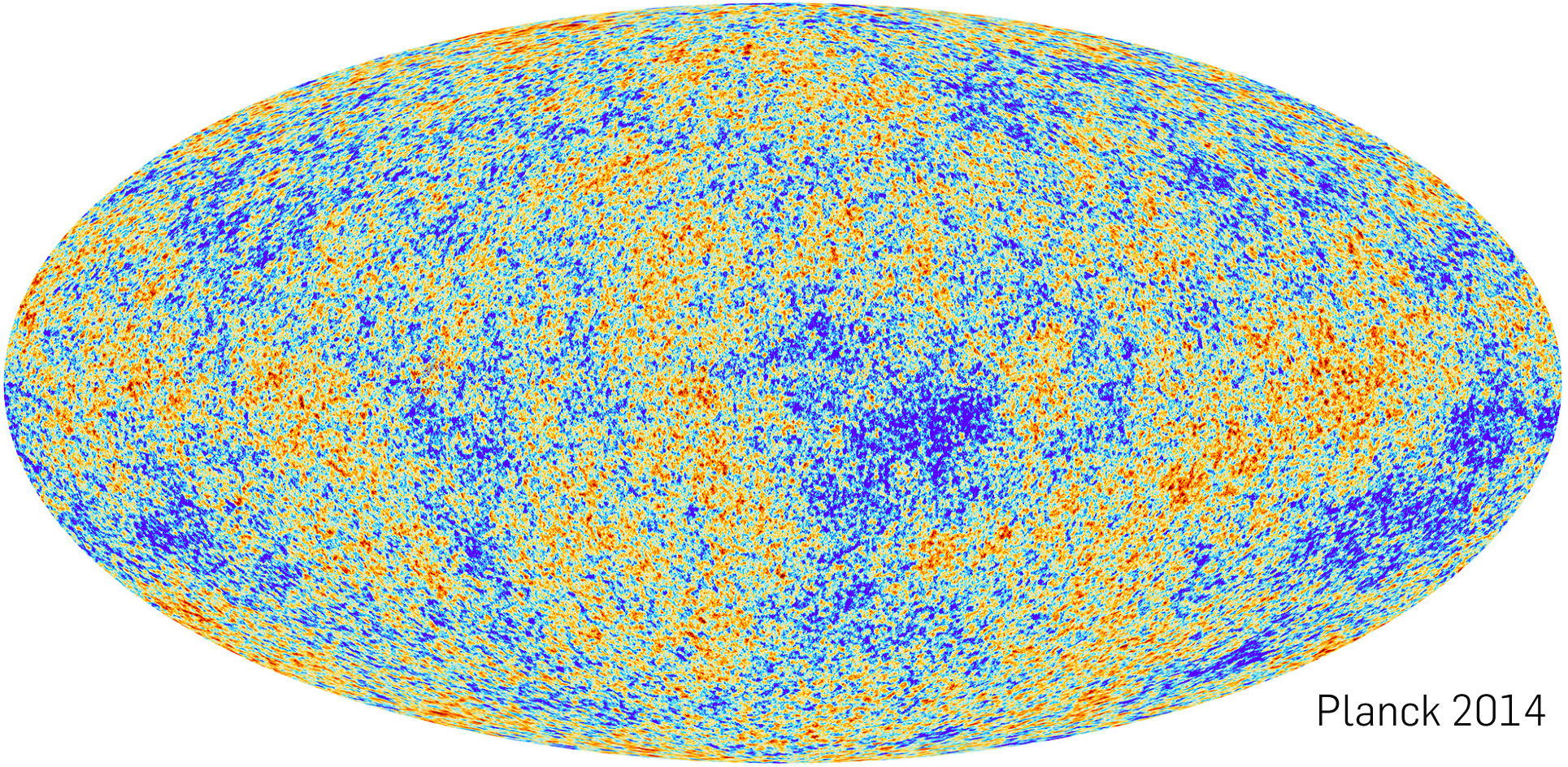


Mundell et al. 2013

BICEP2 in PLANCK



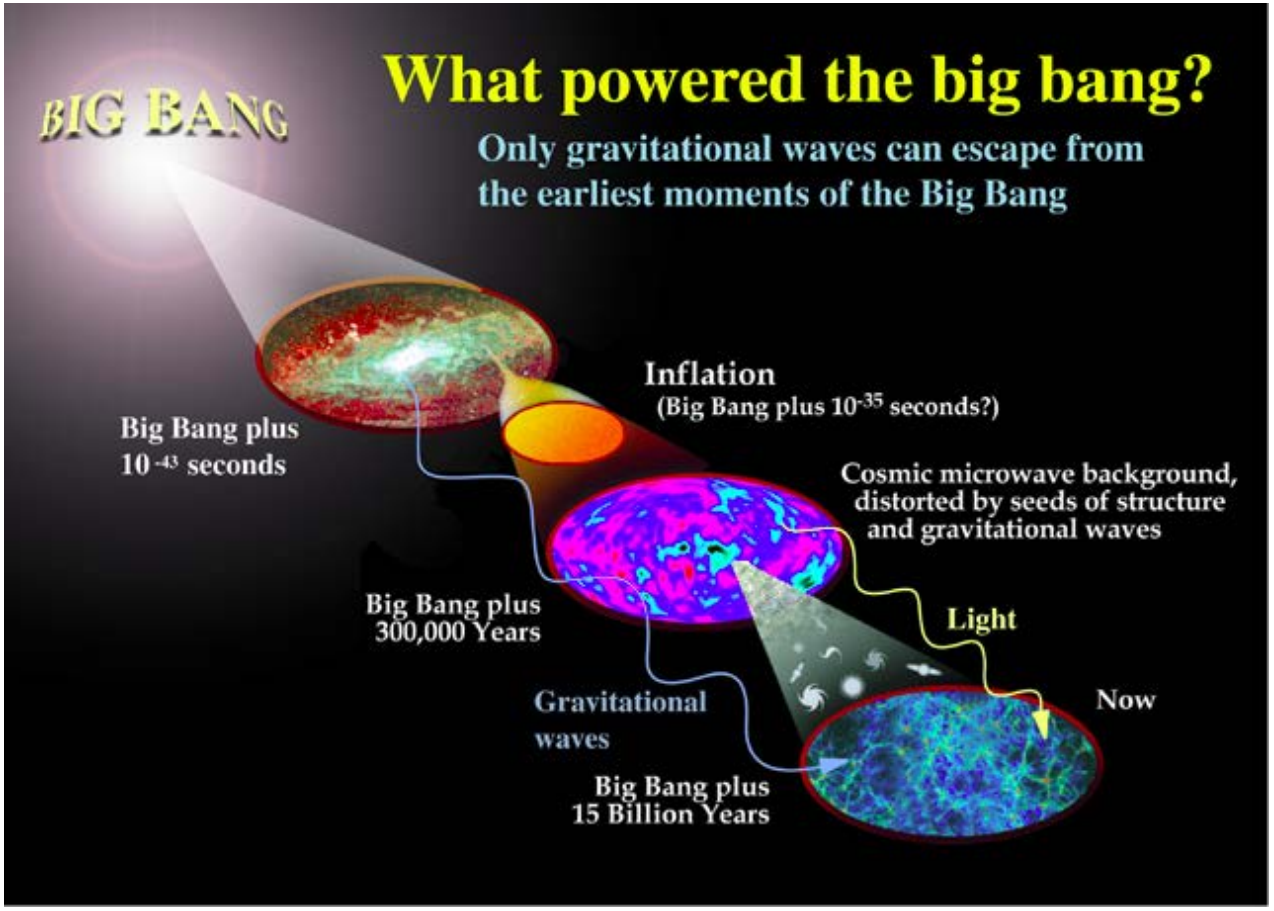
MIKROVALOVNO SEVANJE OZADJA



Planck 2014

- Najstarejša slika vesolja – “portret” pri starosti 380 tisoč let
- Izredno majhna odstopanja: 2.72548K +- 0.00057K
- Temperaturna odstopanja so “seme” poznejših struktur: galaksij in zvezd

GRAVITACIJSKO VALOVANJE



- Signal inflacije, ki naredi vesolje homogeno (vpliv odvisen od modela inflacije)
- Vpliva na polarizacijo mikrovalovnega sevanja ozadja
- Meritve so izjemno zahtevne, saj gre za zelo šibek efekt
- Zaenkrat še ni potrjenega odkritja (meritve BICEP2 ovržene iz strani Planck-a)

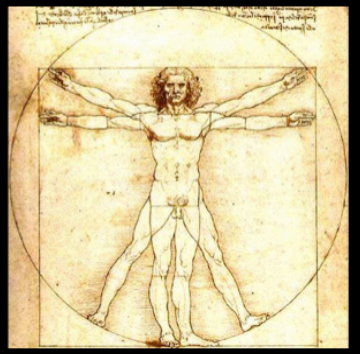
ZAKLJUČEK

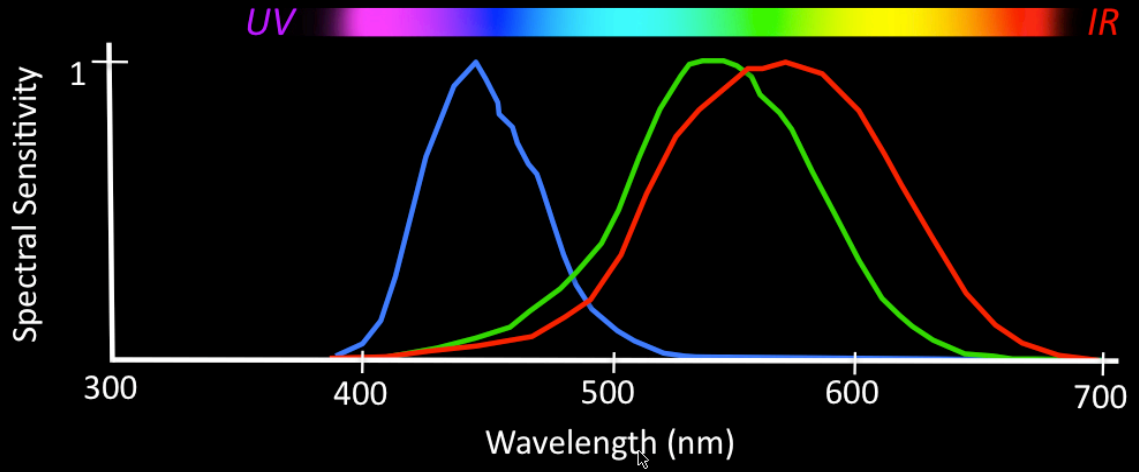
- Polarizacija je vse bolj pomembna na različnih področjih astronomije (predstavljena le 3)
- Polarizirana svetloba lahko nastane pri sipanju, ali pa pri “eksotičnih” sevalnih procesih
- Instrumenti za merjenje polarizacije morajo pokrivati različna območja valovnih dolžin

ZA KONEC – MOJSTROVINE NARAVE

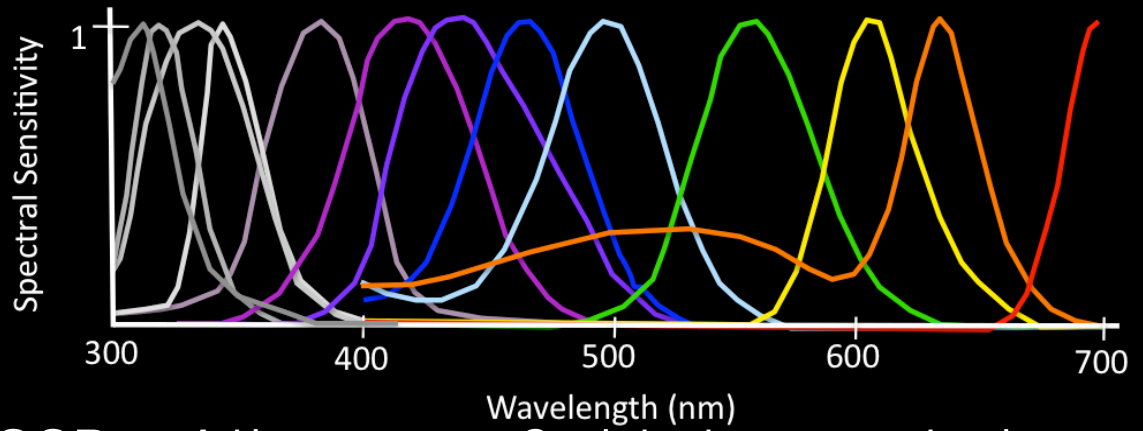
Mantis Shrimp: Extraordinary Eyes

Homo sapiens





Neogonodactylus oestedii



12-barvni hiter CCD + 4 linearna + 2 cirkularna polarizatorja

Marshall *et al.*, 2007; Marshall and Oberwinkler, 1999

Credit R. Caldwell