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On circumpulsar disk characteristics

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Abstract

The presence of circumpulsar disks was claimed to explain measured braking indices of young pulsars and observations from soft gamma repeaters (SGR), anomalous x-ray pulsars (AXPs), rotational radio transients (RRATs) and central compact objects (CCOs). Nevertheless, up to the present time one disk only was detected around the AXP 4U 0142+61 and a single coplanar planetary system was observed around the millisecond pulsar PSR 1257+12.

In a previous work, we have estimated the characteristics (mass, dimensions) of circumpulsar precessing disks detectable with the future DECIGO and BBO interferometers for gravitational wave measurements in space.

We present here a study of possible scenarios leading to the lack of electromagnetic observations of disk formation. Disk masses and dimensions following from these scenarios will be compared with those compatible with the detection of gravitational waves generated by disk precession.

1. Introduction

Disks around pulsars are supposed to build up from supernova fallback material or tidal disruption from a companion star. The observation of coplanar planets surrounding the millisecond pulsar PSR1257+12 [1] and of a disk around the AXP 4U 0142+61 [2] seemed to indicate that circumpulsar disk formation may contribute to pulsar spin down and affect particle production in the pulsar magnetosphere thus explaining observations from pulsars [3, 4], soft gamma repeaters (SGR), anamalous x-ray pulsars (AXPs), rotational radio transients (RRATs) and central compact objects (CCOs). Unfortunately, several campaigns of observations did not lead to any further disk detection, even though multimessenger clues on average pulsar initial periods suggest that disk formation is allowed around a large fraction of pulsars [5, 6].

We investigate different scenarios leading to this experimental evidence and we consider the corresponding characteristics of circumpulsar disks.

2. Circumpulsar disk detection

The sensitivity of the future interferometers for gravitational wave detection in space [7, 8] will allow for the detection of circumpulsar precessing disks with masses larger than 10^{27} kg assuming small wobble angles. Larger wobble angles would allow for disk detection with masses larger than 10^{25} kg up to distances of tens of kpc. Space interferometer mission durations of one and 10 years were considered to set these limits [6]. Constrains on disk masses and dimensions can also be set by infrared observations. We present a study of compatibility of present infrared observations and future gravitational wave observations from circumpulsar precessing disks.

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