

Die Kosmische Hintergrundstrahlung Zeugin des Urknalls

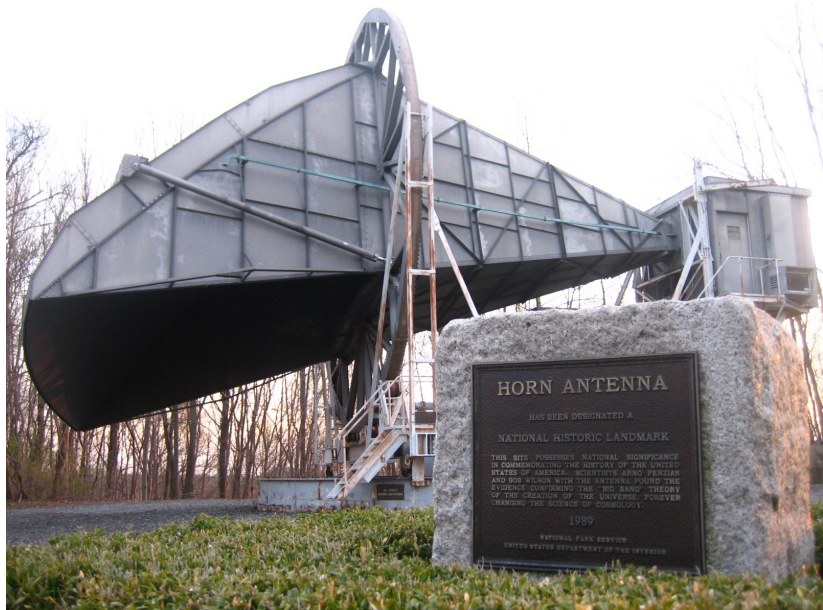
Matthias Bartelmann

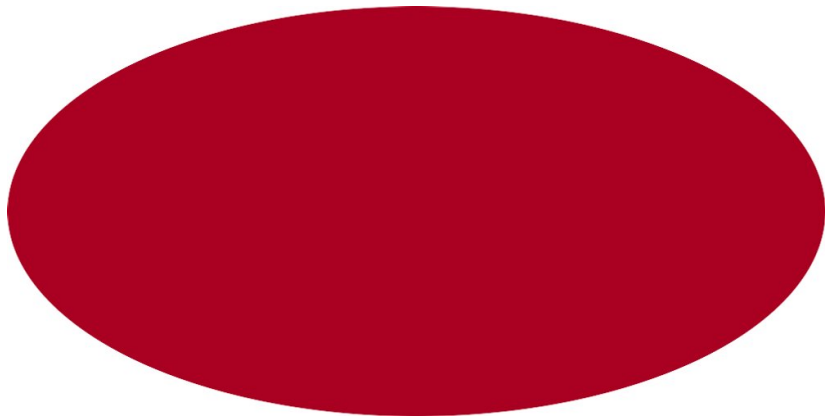
Universität Heidelberg, Zentrum für Astronomie,
Institut für Theoretische Astrophysik

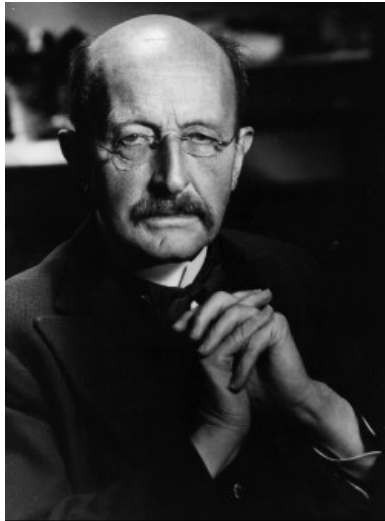
Vom Urknall zur zweiten Erde, Schwetzingen, 23.02.2019





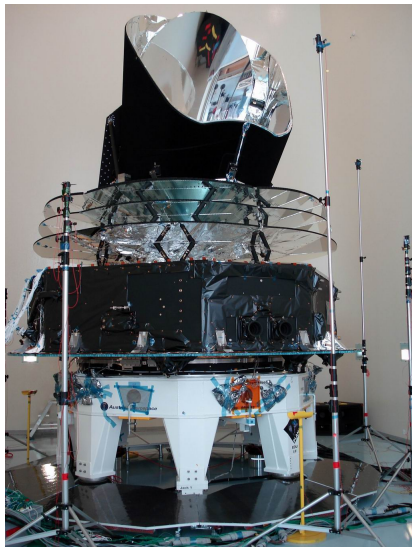




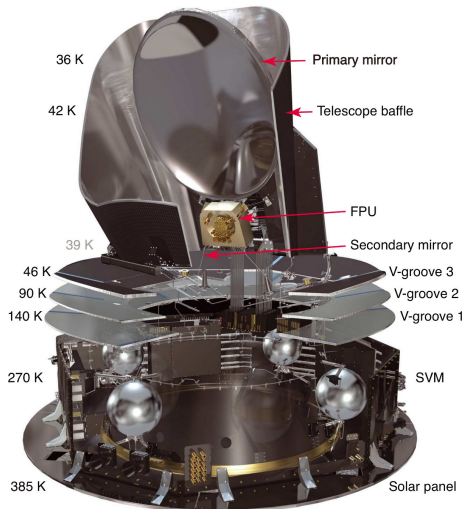
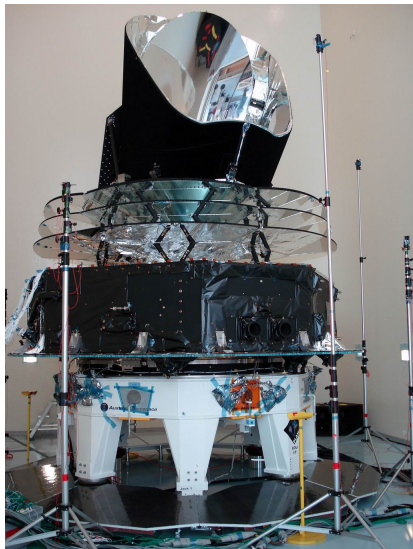


Max Planck, 1858-1947

Planck, der Satellit

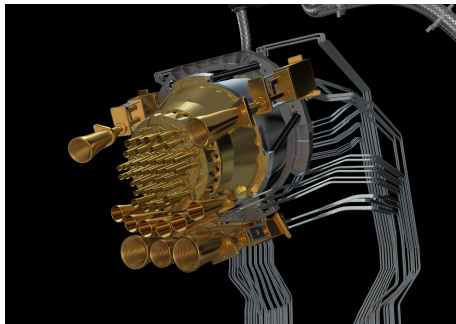


Planck, der Satellit



Aufgaben:

- Den Mikrowellenhimmel mit 5' Winkelauflösung abbilden
- Dabei möglichst kein Lichtquant verlieren
- Bei neun Frequenzen zwischen 30 und 857 GHz



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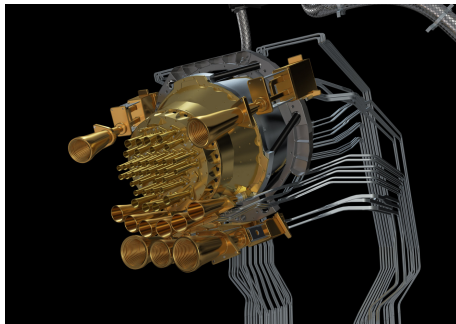


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Instrumente:

- Niederfrequenzinstrument (LFI) bis 100 GHz
- Hochfrequenzinstrument (HFI) ab 100 GHz



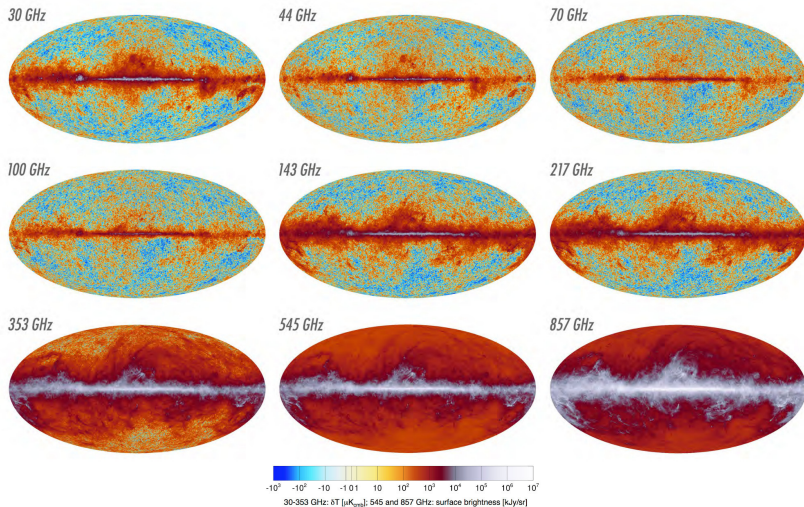


Kourou, 14. Mai 2009, 15:12 MESZ

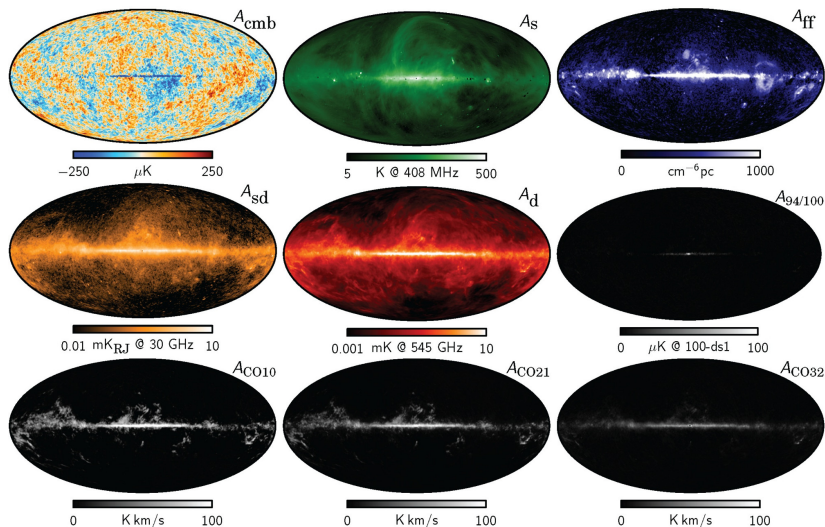


in Betrieb zwischen 13. Aug. 2009 und 23. Okt. 2013

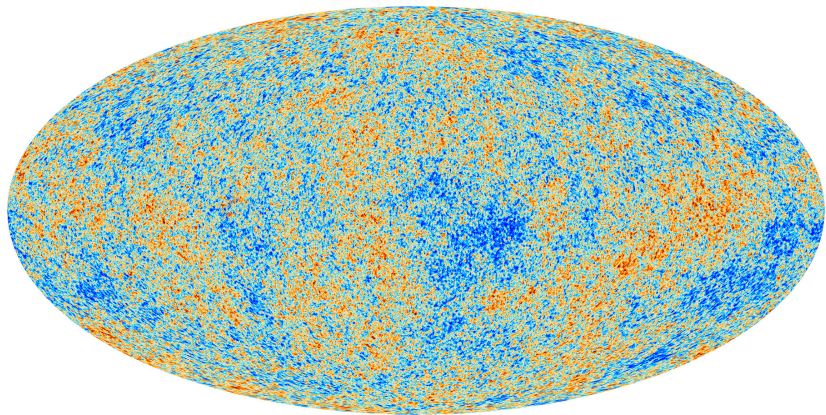
Himmelskarten bei verschiedenen Frequenzen



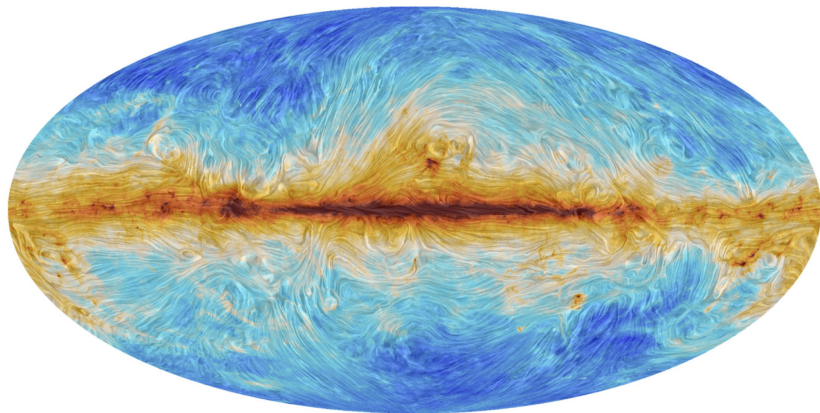
Himmelskarten der Komponenten



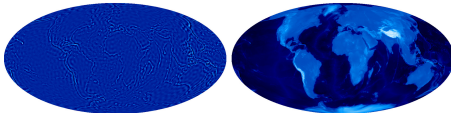
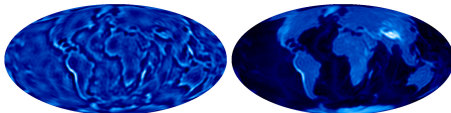
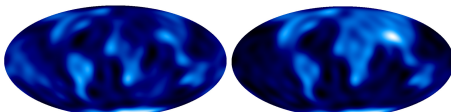
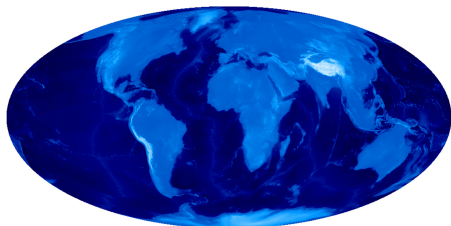
Temperaturkarte des kosmischen Hintergrunds



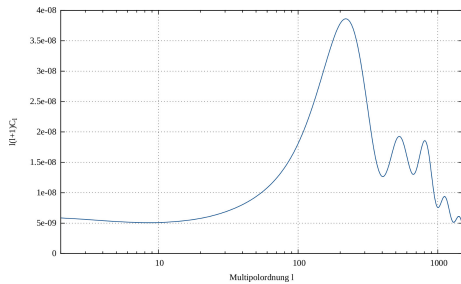
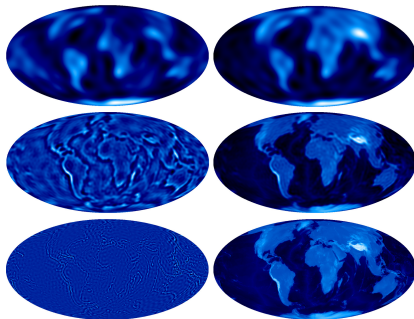
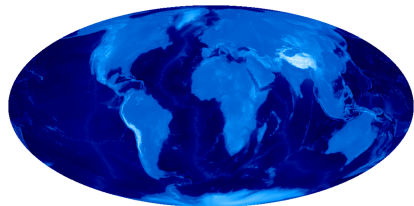
Temperatur



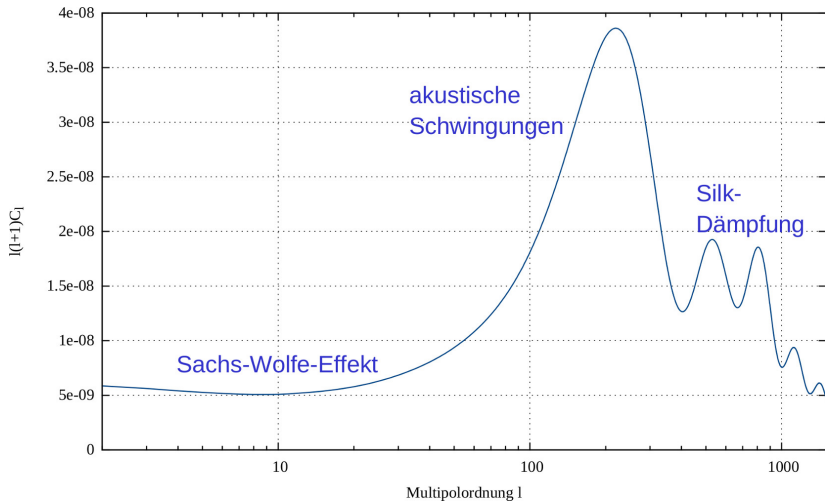
Polarisationswinkel bei 353 GHz



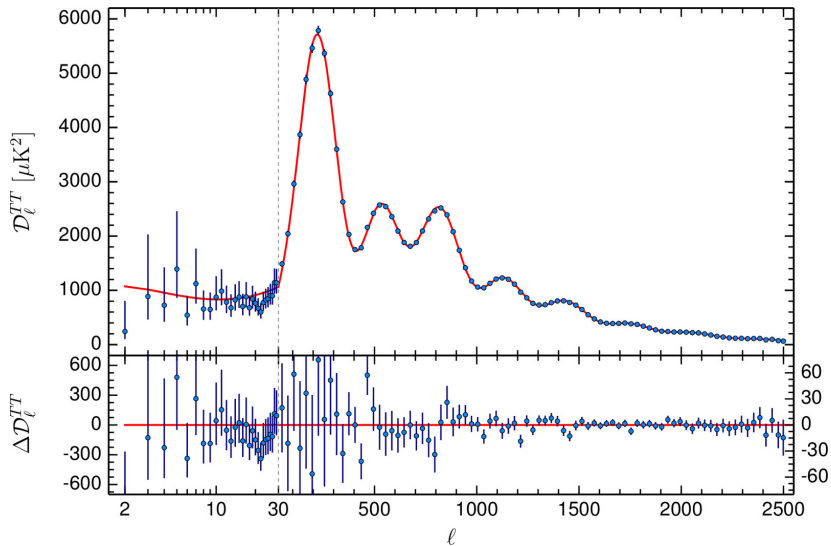
Das kosmische Konzert



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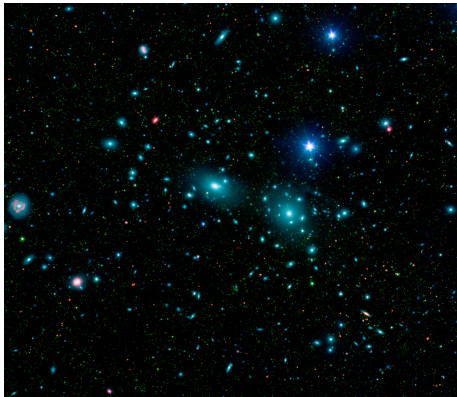


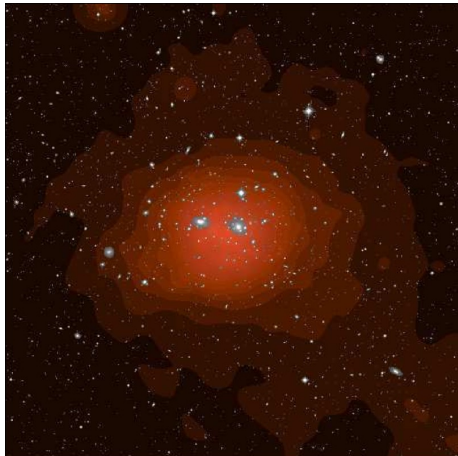
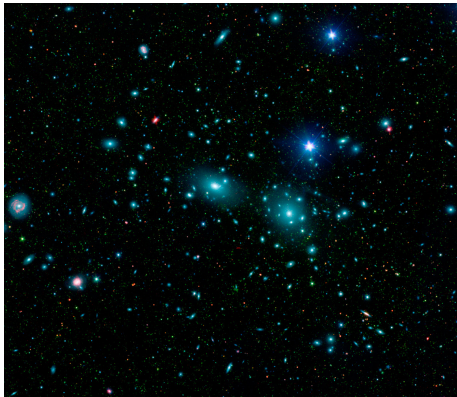
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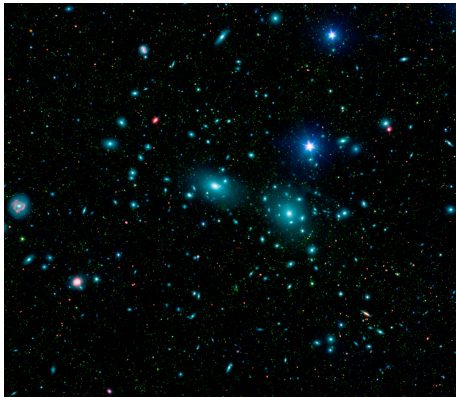


Parameter	Wert			Bedeutung
$100 \Omega_{B0} h^2$	2.226	\pm	0.016	Baryondichte
$\Omega_{c0} h^2$	0.1193	\pm	0.0014	Dichte dunkler Materie
100θ	1.04087	\pm	0.00032	Lage des Maximums
τ	0.063	\pm	0.014	Optische Tiefe
$\ln(10^{10} A_s)$	3.059	\pm	0.025	Amplitude
n_s	0.9653	\pm	0.0048	Spektralindex

Keine Erweiterung des Modells hat eine verbesserte Beschreibung der Daten ergeben.



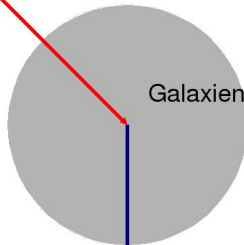




energiearmes Photon
fällt ein



Galaxienhaufen

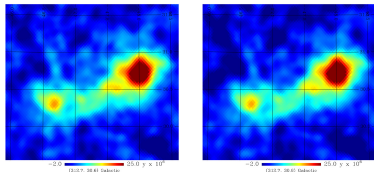


energiereiches Photon
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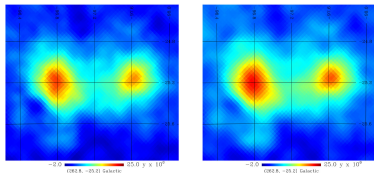


Beobachter

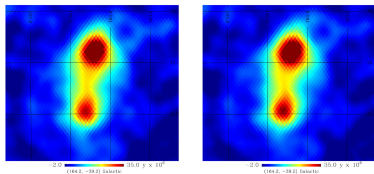
(a) Shapley supercluster



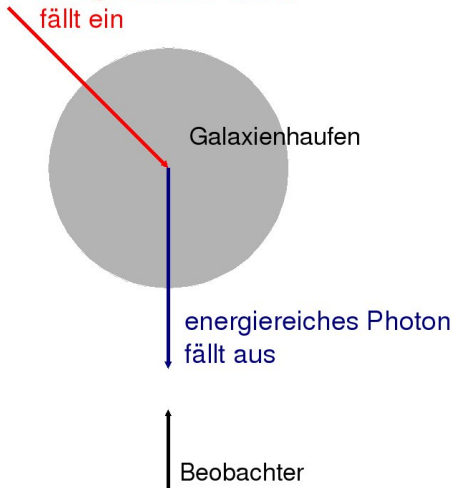
(b) A3395-A3391 merger system



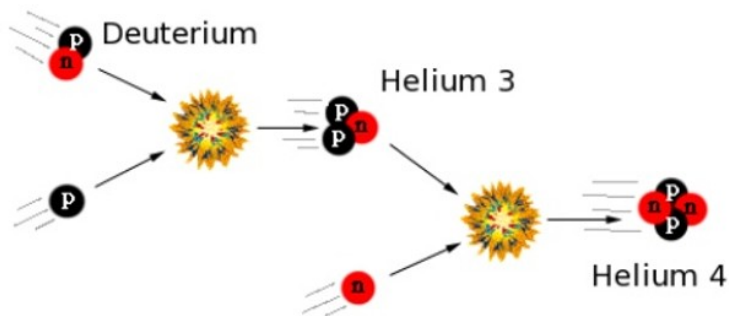
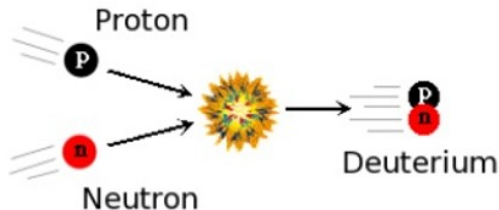
(c) A339-A401 merger system



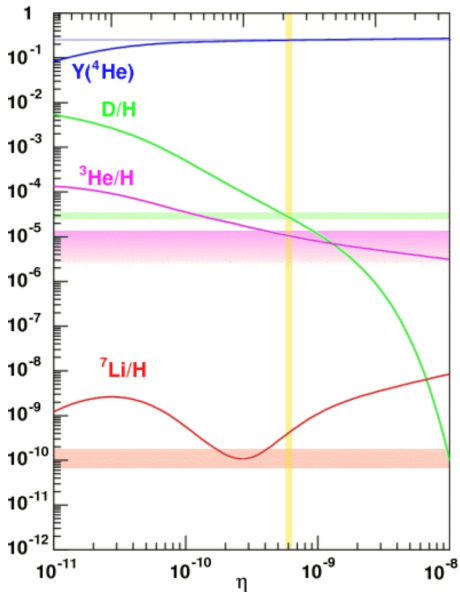
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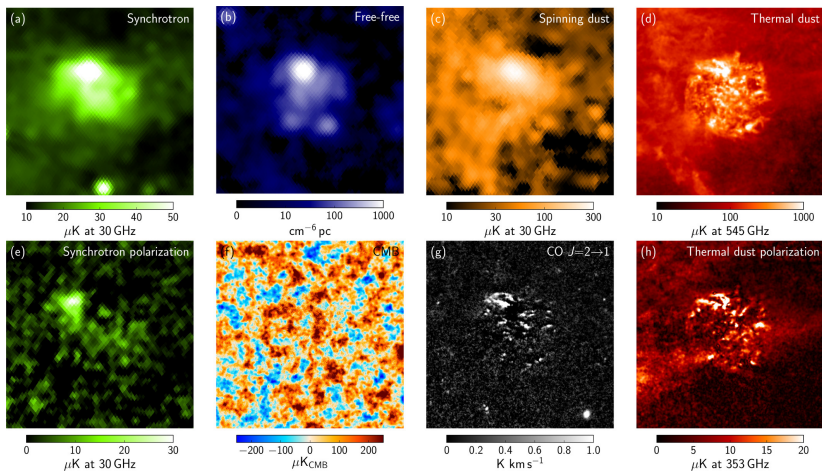


Die ersten chemischen Elemente



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Polarisiertes Licht aus der Milchstraße

