The dynamic spectra of the bursts in Extended Data Fig. 1 show narrow-band striations that are consistent with diffractive interstellar scintillations caused by turbulent plasma in the Milky Way. The autocorrelation functions of the burst spectra show three features: a very narrow feature from radiometer noise, a narrow but resolved feature corresponding to the striations, and a broad feature related to the extent of the burst across the frequency band. The striation feature has a half-width that varies between about 2 MHz and 5 MHz from burst to burst and is comparable to the scintillation bandwidth expected from the Milky Way in the direction of FRB 121102. The NE2001 electron density model[40] provides an estimate $\tau \approx 16\,\mu s$ for the pulse broadening time at 1 GHz. This predicts a scintillation bandwidth of about $\nu^{4.4}/(2\pi\tau)$ that ranges from 5 MHz to 11 MHz across the 4.1–4.9 GHz band. We conclude that the measured autocorrelation functions and the NE2001 model prediction are consistent to within their uncertainties and that the narrow striations are due to Galactic scintillations.

A model for the rotation measure and scattering measure of FRB 121102. *Rotation measure constraints.* The measured $RM_{obs} \approx +1 \times 10^5$ rad m^{-2} implies a source frame value

$$RM_{src} = (1+z)^2 RM_{obs} \approx +1.4 \times 10^5 \text{ rad m}^{-2} \quad (6)$$

We can use the previously estimated[8] $DM_{host} \approx 70$–270 pc cm^{-3} (in the source frame) and RM_{src} to constrain the properties of the region in which the Faraday rotation occurs. In the absence of other information, we can set a constraint on the average magnetic field along the line of sight in the Faraday region using the ratio

$$B_{\|} = \frac{RM_{src}}{0.81 DM_{host}} = [0.6 \text{ mG}, 2.4 \text{ mG}] \quad (7)$$

If only a small portion of the total dispersion measure of FRB 121102 is from the highly magnetized region, the field could be much higher.

Scattering measure constraints. The best constraint on pulse broadening comes from the measurement of the scintillation (diffraction) bandwidth of $\Delta\nu_d \approx 5$ MHz at 4.5 GHz (see above). This implies a pulse broadening time at 1 GHz of

$$\tau(1 \text{ GHz}) \approx (2\pi\Delta\nu_d)^{-1} \times (4.5 \text{ GHz}/1 \text{ GHz})^{4.4} = 24\ \mu s \quad (8)$$

This scattering time is consistent with that expected from the Milky Way using the NE2001 model[40] and therefore is an upper bound on any contribution from the host galaxy. Compared to scattering in the Milky Way, this upper bound is below the mean trend for any of the plausible values of DM_{host}, especially when the correction from spherical to plane waves is taken into account[41].

Compared with the observer frame, the ratio τ/DM_{host} is a factor of $(1+z)^2 = 1.42$ larger in the source frame but that is still far from sufficient to account for the apparent scattering deficit with respect to the Galactic τ/DM ratio. Given the apparent extreme conditions of the plasma in the host galaxy, it would not be surprising if its turbulence properties caused a scattering deficit. For example, scattering is reduced if the inner scale is comparable to or larger than the Fresnel scale owing to either a large magnetic field or a high temperature.

Constraints on the properties of the Faraday region. Comparison of the magnetic field and thermal energy densities enables us to constrain the electron density and temperature and the length scale of the region responsible for the observed Faraday rotation. We parametrize this relation with

$$\beta \frac{B^2}{8\pi} = 2 n_e k_B T_e \quad (9)$$

where β is a scaling factor, B is the magnetic field strength and k_B is the Boltzmann constant. This assumes a 100% ionized gas of pure hydrogen with temperature equilibration between protons and electrons. Under equipartition, $\beta = 1$. In more densely magnetized regions, $\beta \ll 1$. Field reversals will reduce the total rotation measure, requiring a lower value of β in order to match constraints. The absence of free–free absorption at a frequency of about 1 GHz sets an additional constraint on the permitted parameter space.

In Extended Data Fig. 6, we explore a range of physical environments. We consider a lower limit, DM = 1 pc cm^{-3}, on the dispersion measure that is smaller than the previously estimated[8] $DM_{host} \approx 70$–270 pc cm^{-3} because it is possible that not all of the dispersion measure originates from the Faraday region. Galactic H II regions typically have $|RM|$ smaller than about 3×10^2 rad m^{-2} and weak magnetic fields[42] with β greater than about 1, although calculations suggest that it is possible for H II regions to achieve high rotation measures under some circumstances[43]. The parameter space for a typical H II-region plasma at $T_e = 10^4$ K is almost entirely excluded, and many possible H II region sizes and densities[21] are incompatible with the DM_{host} constraints. At higher T_e, wide ranges of the parameter space are permitted. In the case of equipartition, we have explicit unique solutions. For $T_e = 10^6$ K, we find a density of $n_e \approx 10^2$ cm^{-3} on a length scale $L_{RM} \approx 1$ pc, comparable to the upper limit of the size of the persistent source. Higher-temperature gas ($T_e = 10^8$ K) can be extended to $L_{RM} \approx 100$ pc. For both of these solutions, the characteristic magnetic field strength is about 1 mG.

The large rotation measure of FRB 121102 is similar to those seen towards massive black holes; notably, RM $\approx -5 \times 10^5$ rad m^{-2} is measured near Sagittarius A*, the Milky Way's central black hole, and probes scales below 10^4 Schwarzschild radii (about 0.001 pc)[11,12]. The constraints on n_e, T_e and L_{RM} are also consistent with the environment around Sagittarius A* (Extended Data Fig. 6). The high rotation measure towards the Galactic Centre magnetar PSR J1745−2900 (Fig. 3), RM = -7×10^4 rad m^{-2}, at a projected distance[23,44] of about 0.1 pc from Sagittarius A*, is evidence of a dynamically organized magnetic field around Sagittarius A* that extends to the distance of the magnetar[23]. Notably, radio monitoring of PSR J1745−2900 for about 4.5 years has shown a decrease of around 5% in the magnitude of the observed rotation measure, while the dispersion measure remained constant at a level of about 1% (Desvignes, G. *et al.*, manuscript in preparation). This suggests large fluctuations in magnetic field strength in the Galactic Centre on scales of roughly 10^{-5} pc.

The high rotation measure and the rich variety of other phenomena[4,5,7–10,15,16] displayed by the FRB 121102 system suggest that the persistent radio counterpart to FRB 121102 could represent emission from an accreting massive black hole, with the surrounding star formation representing a circum-black-hole starburst. Given the mass of the host galaxy and typical scaling relationships[45], the mass of the black hole would be about 10^4–10^6 solar masses ($M_\odot$). The observed radio brightness and compactness of the source, as well as the optical and X-ray non-detections[8,10,16], are compatible with such a black hole and an inefficient accretion state (about $10^{-6} L_{Edd}$–$10^{-4} L_{Edd}$, where L_{Edd} is the Eddington luminosity).

While models considering the presence of only a massive black hole have been proposed[46], there is no observational precedent for microsecond bursts created in such environments. Rather, the FRB 121102 bursts themselves could arise from a neutron star, perhaps highly magnetized and rapidly spinning, near an accreting massive black hole. The proximity of PSR J1745−2900 to Sagittarius A* demonstrates that such a combination is possible. In this model, the black hole is responsible for the observed persistent source, whereas the bursts are created in the magnetosphere of the nearby neutron star[47].

Alternatively, the association of FRB 121102 with a persistent radio source has been used to argue that the radio bursts are produced by a young magnetar powering a luminous wind nebula[13,48]. This model is not well motivated by Galactic examples, since the most luminous (non-magnetar-powered) Galactic pulsar wind nebula is 500,000 times less luminous than the persistent source that is coincident with FRB 121102, and Galactic magnetars have no detectable persistent radio wind nebulae[49,50]. Also, although giant flares from magnetars can produce relativistic outflows[51], an upper limit of the rotation measure from one such outburst[52] is four orders of magnitude below that observed for FRB 121102.

Nonetheless, under the millisecond magnetar model, the properties of the persistent source constrain the age of the putative magnetar to between several years and several decades, with a spin-down luminosity of 10^8 to 10^{12} times higher than any local analogue[13]. Furthermore, the millisecond magnetar model predicts that the nebula magnetic field strength scales with the integrated spin-down luminosity of the magnetar[13,48]. Extended Data Fig. 6 shows a range of sizes, densities and temperatures for the Faraday-rotating medium that are consistent with Crab-like pulsar wind nebulae, known supernova remnants and a simple model for swept-up supernova ejecta.

Data availability. The calibrated burst data are available upon request from the corresponding author.

Code availability. The codes used to analyse the data are available at the following sites: PRESTO (https://github.com/scottransom/presto), PSRCHIVE (http://psrchive.sourceforge.net) and DSPSR (http://dspsr.sourceforge.net).

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