# Harder, better, faster, stronger authentication with OpenID Connect

Overview of the next-gen authentication stack for Matrix

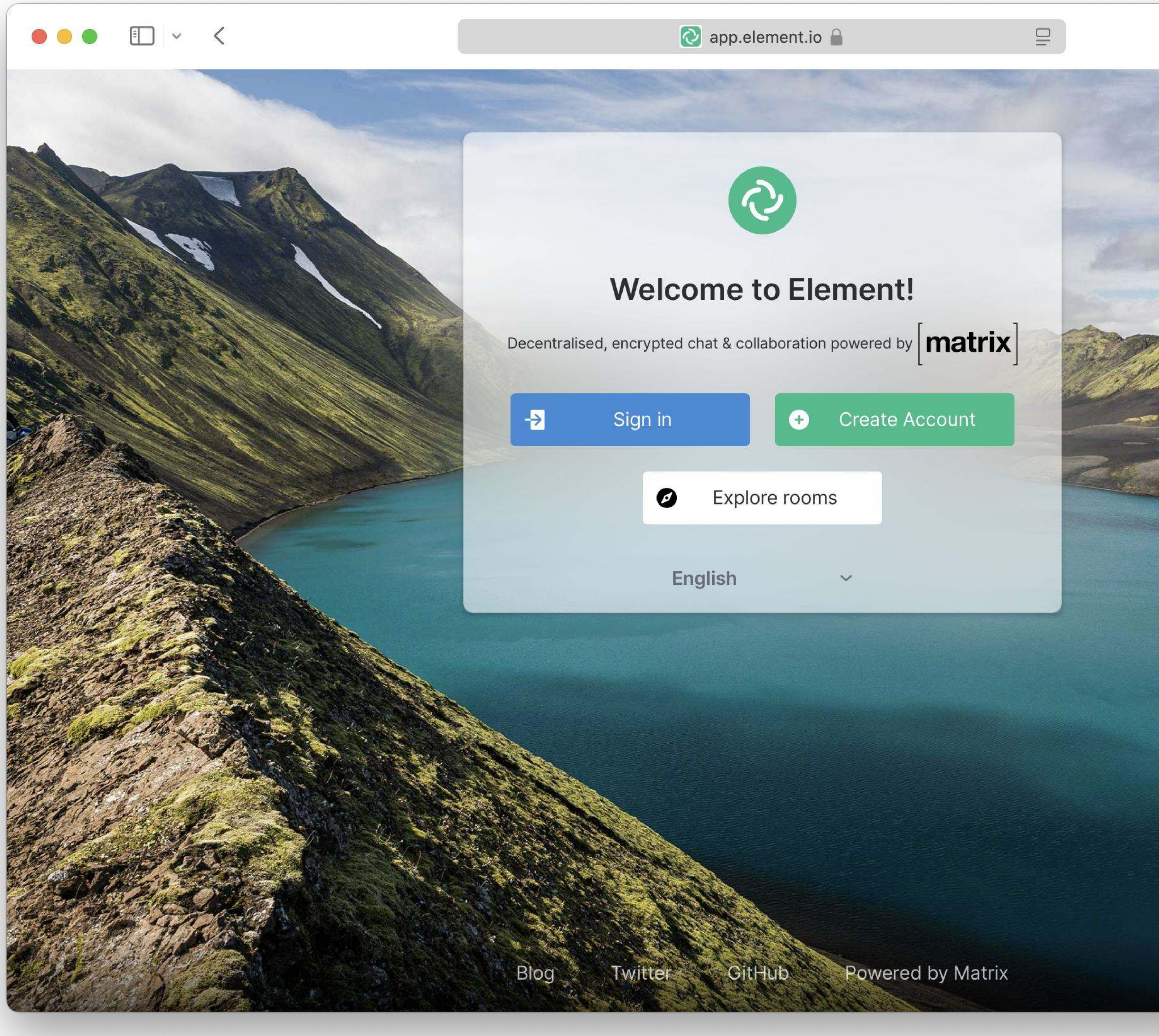
**Quentin Gliech**

Software engineer at Element

@quenting:element.io

# Let me show you first

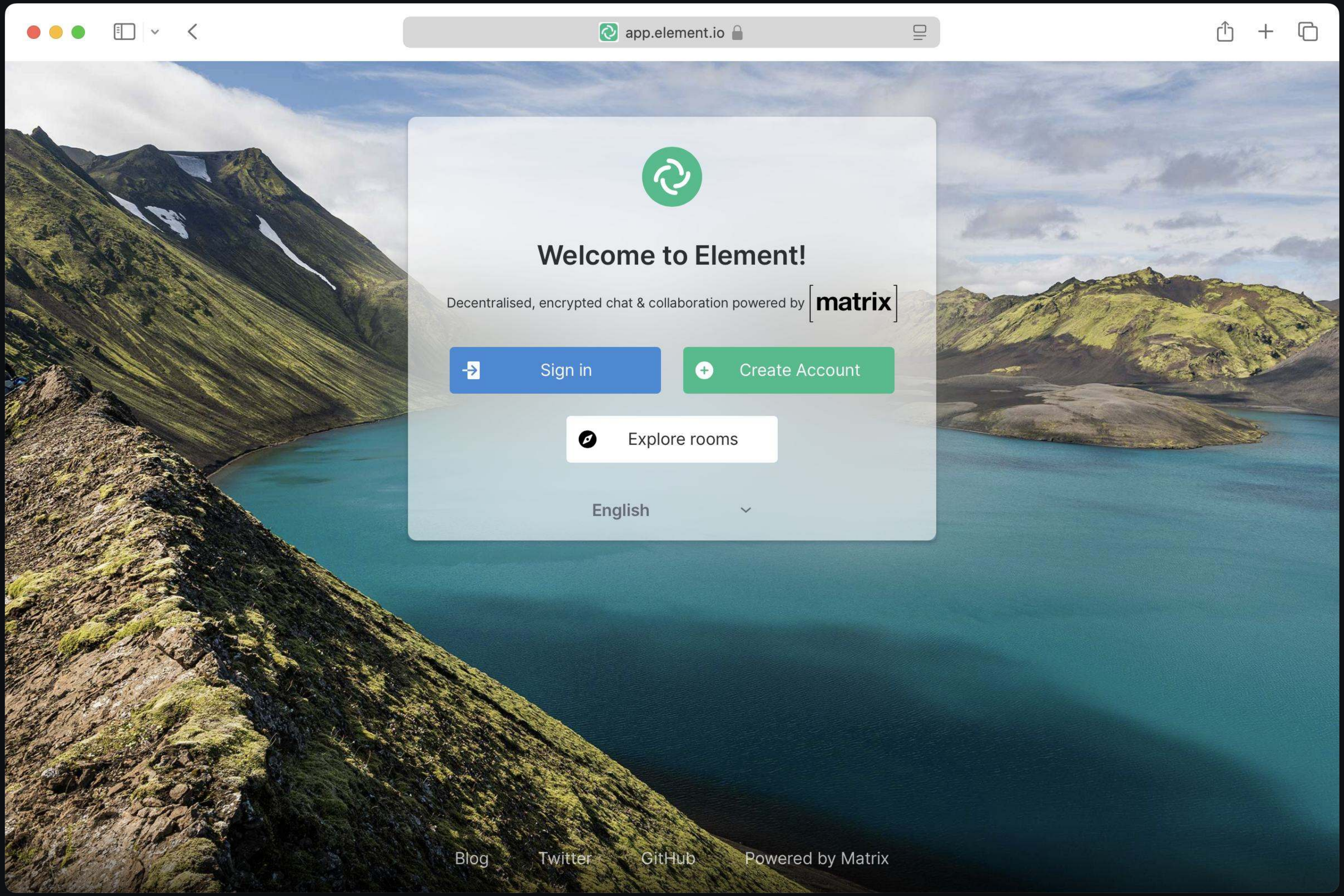
I'm a new Matrix user,
registering a new account in Element Web



app.element.io

Welcome to Element!

Decentralised, encrypted chat & collaboration powered by [matrix]



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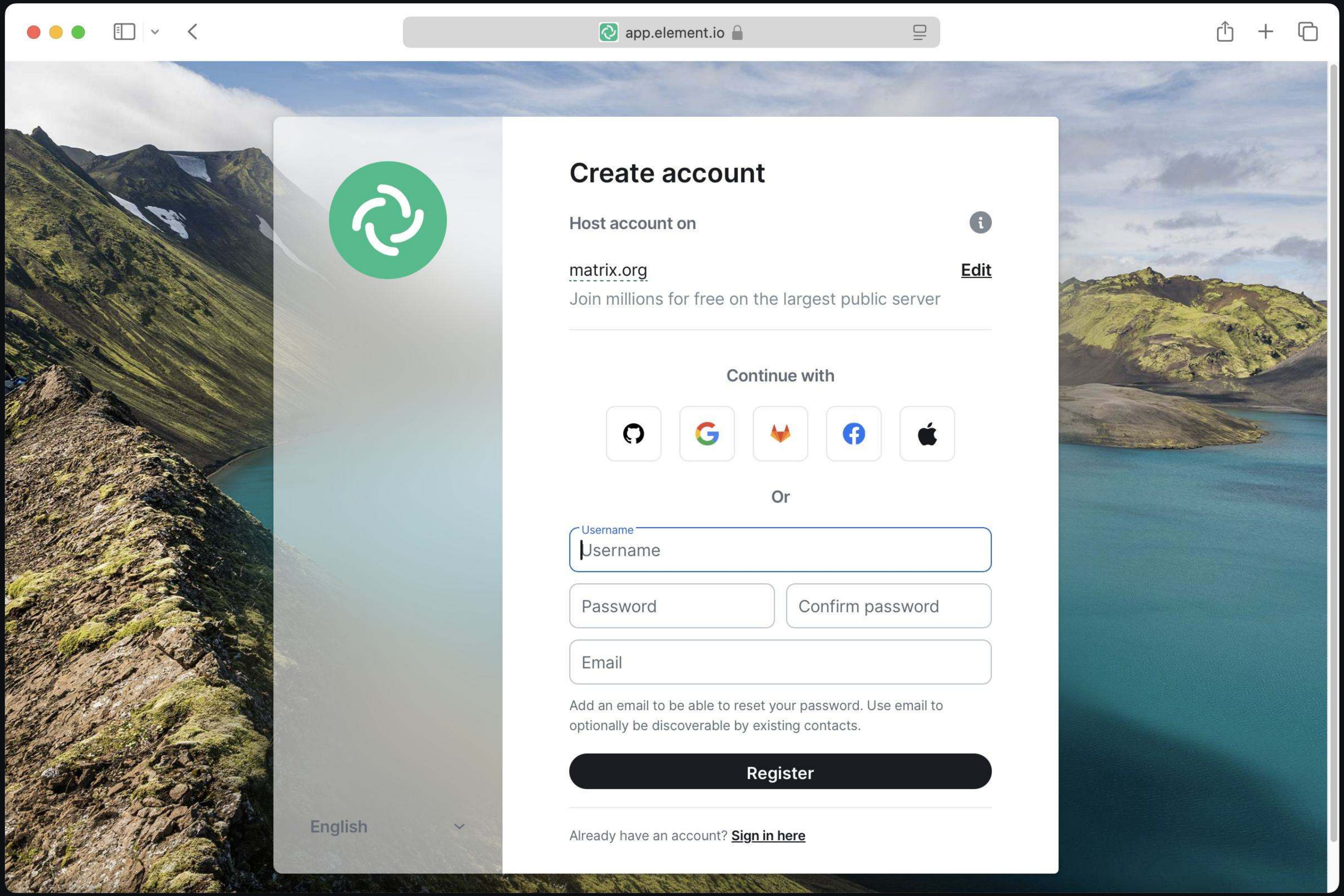


## Create account

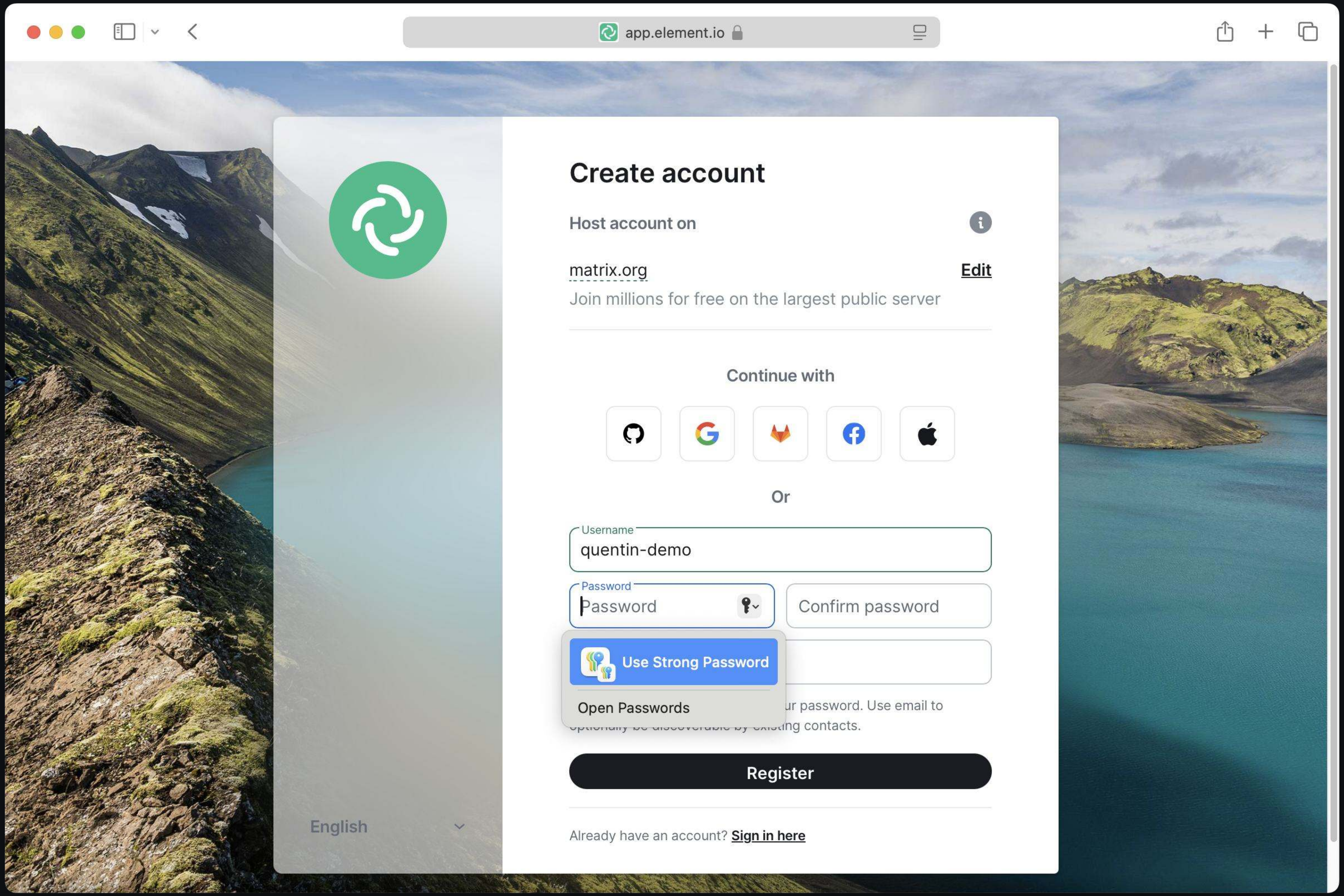
Host account on

matrix.org

Join millions for free on the largest public server

Add an email to be able to reset your password. Use email to optionally be discoverable by existing contacts.

Already have an account? Sign in here



Username: quentin-demo

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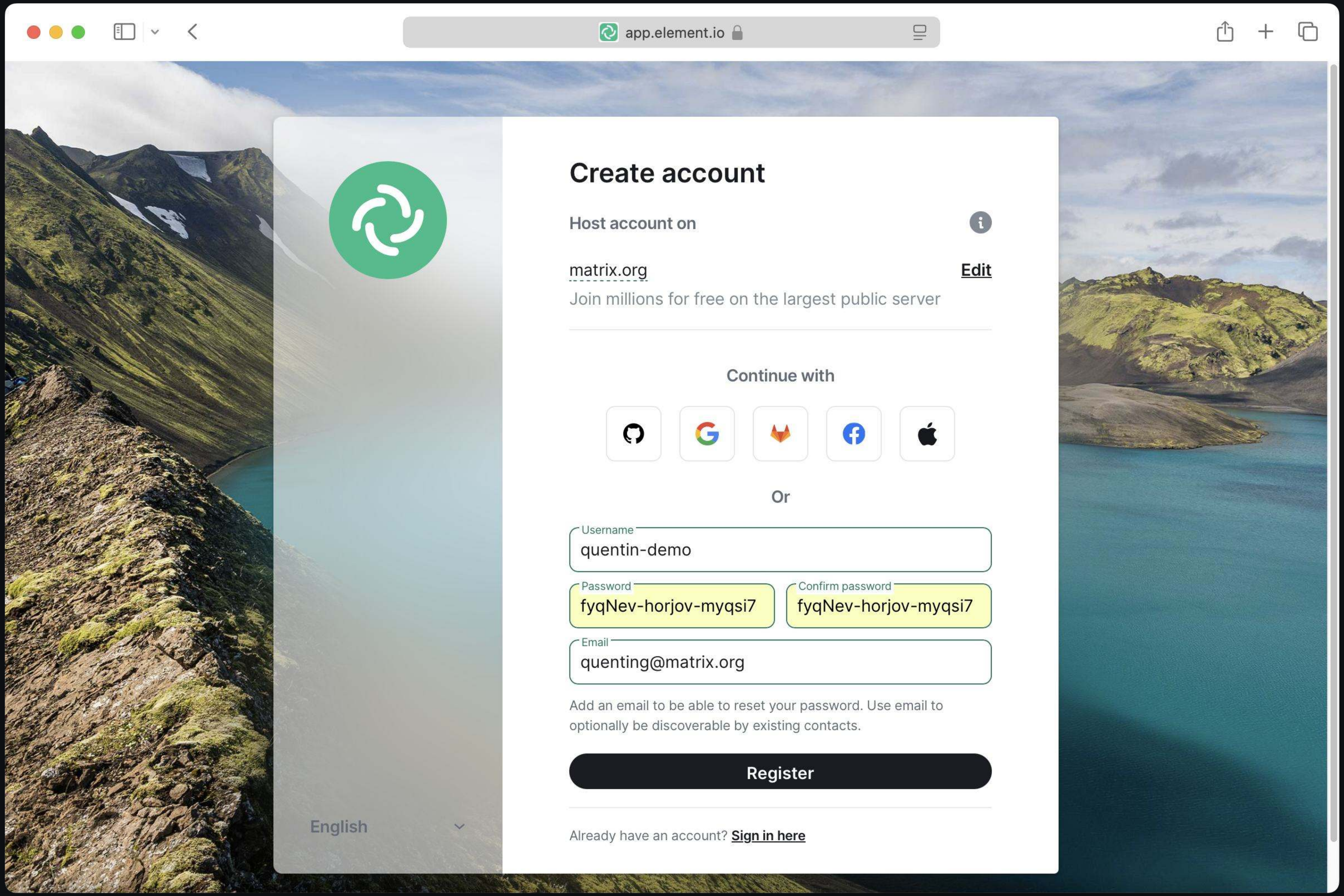

## Create account

Host account on

matrix.org

Join millions for free on the largest public server

Continue with

Or

Username: quentin-demo

Password: fyqNev-horjov-myqsi7

Confirm password: fyqNev-horjov-myqsi7

Email: quenting@matrix.org

Add an email to be able to reset your password. Use email to optionally be discoverable by existing contacts.

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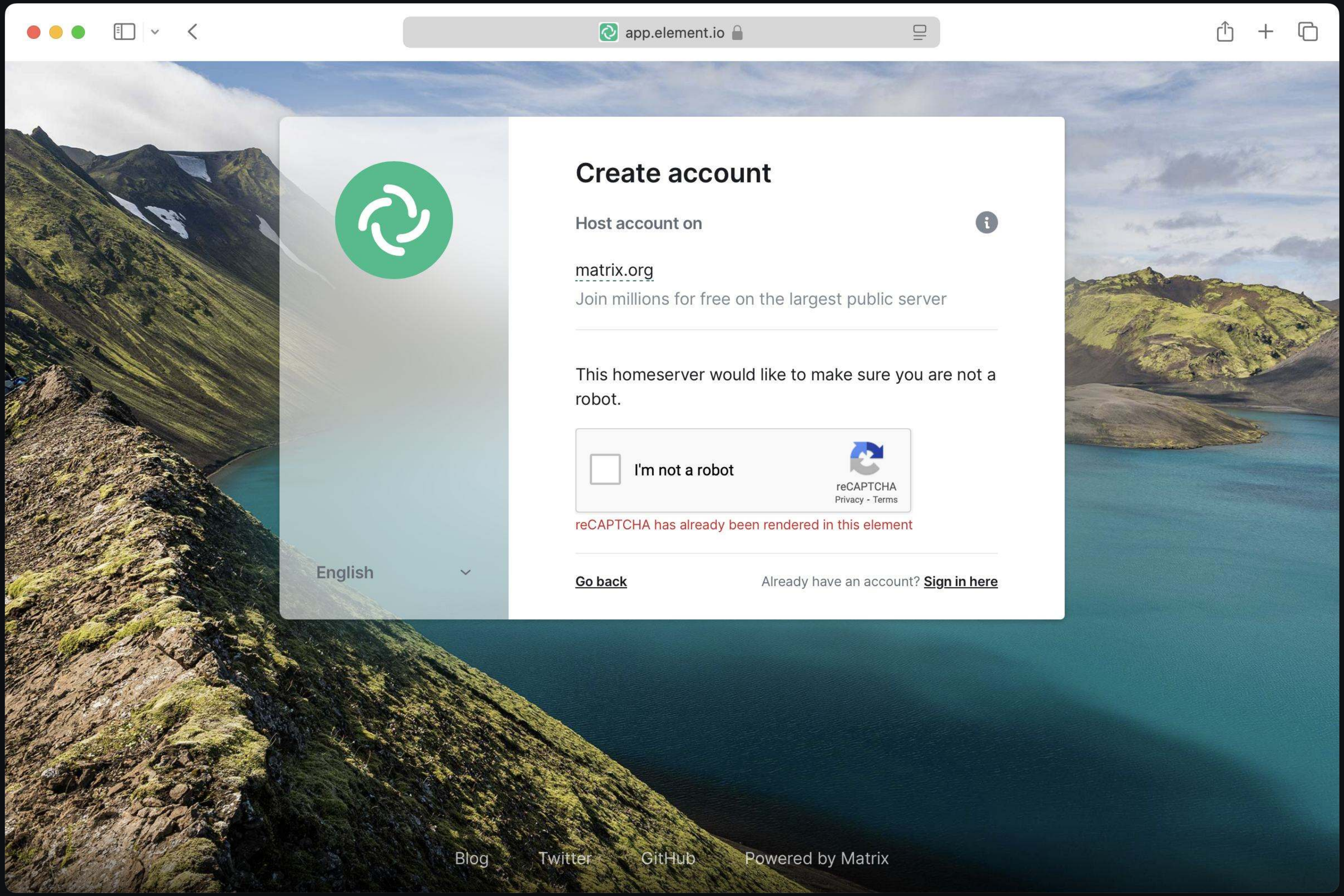

## Create account

Host account on

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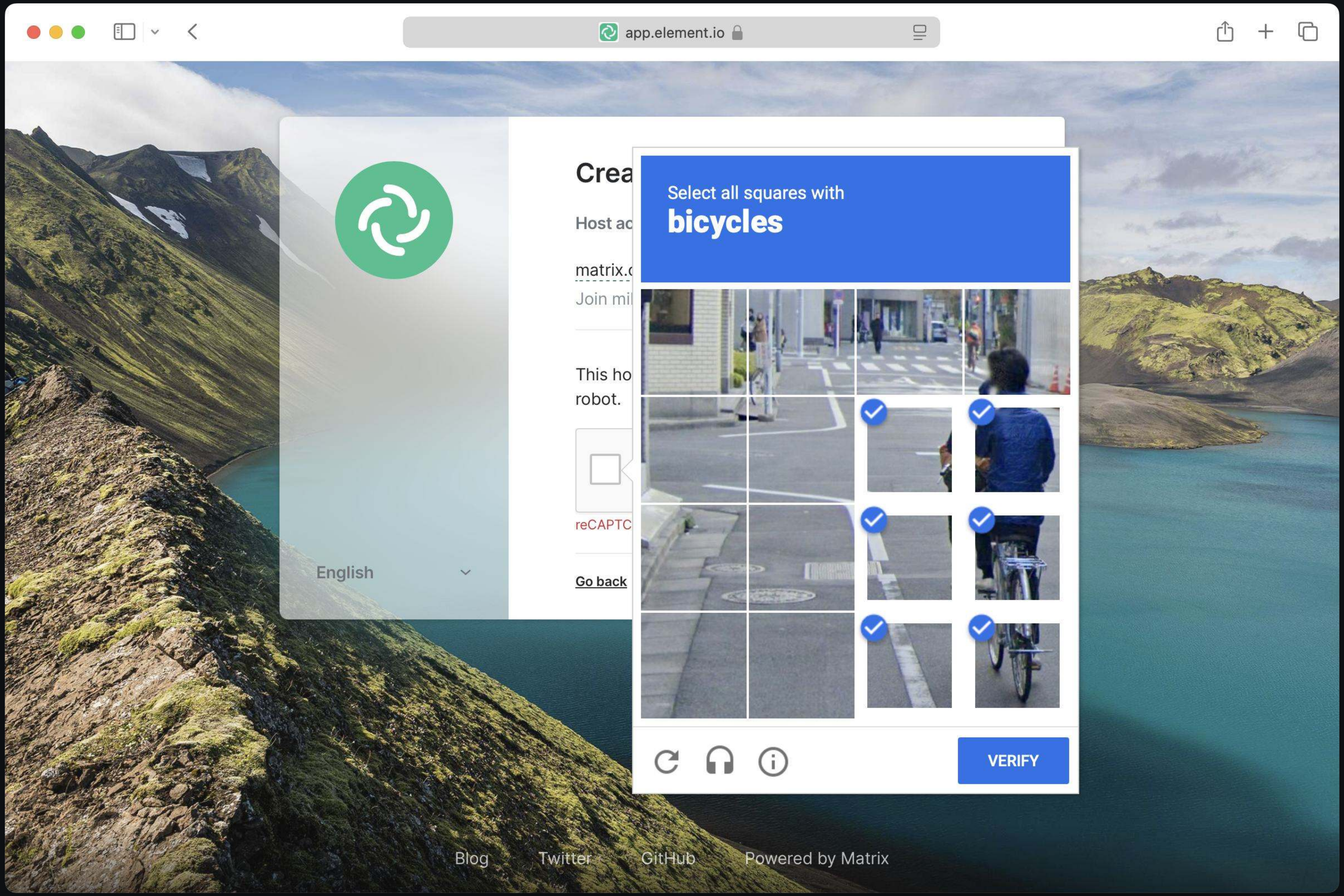
This homeserver would like to make sure you are not a robot.

□ I'm not a robot

reCAPTCHA has already been rendered in this element

**Go back**

Already have an account? **Sign in here**



Select all squares with
**bicycles**

Crea

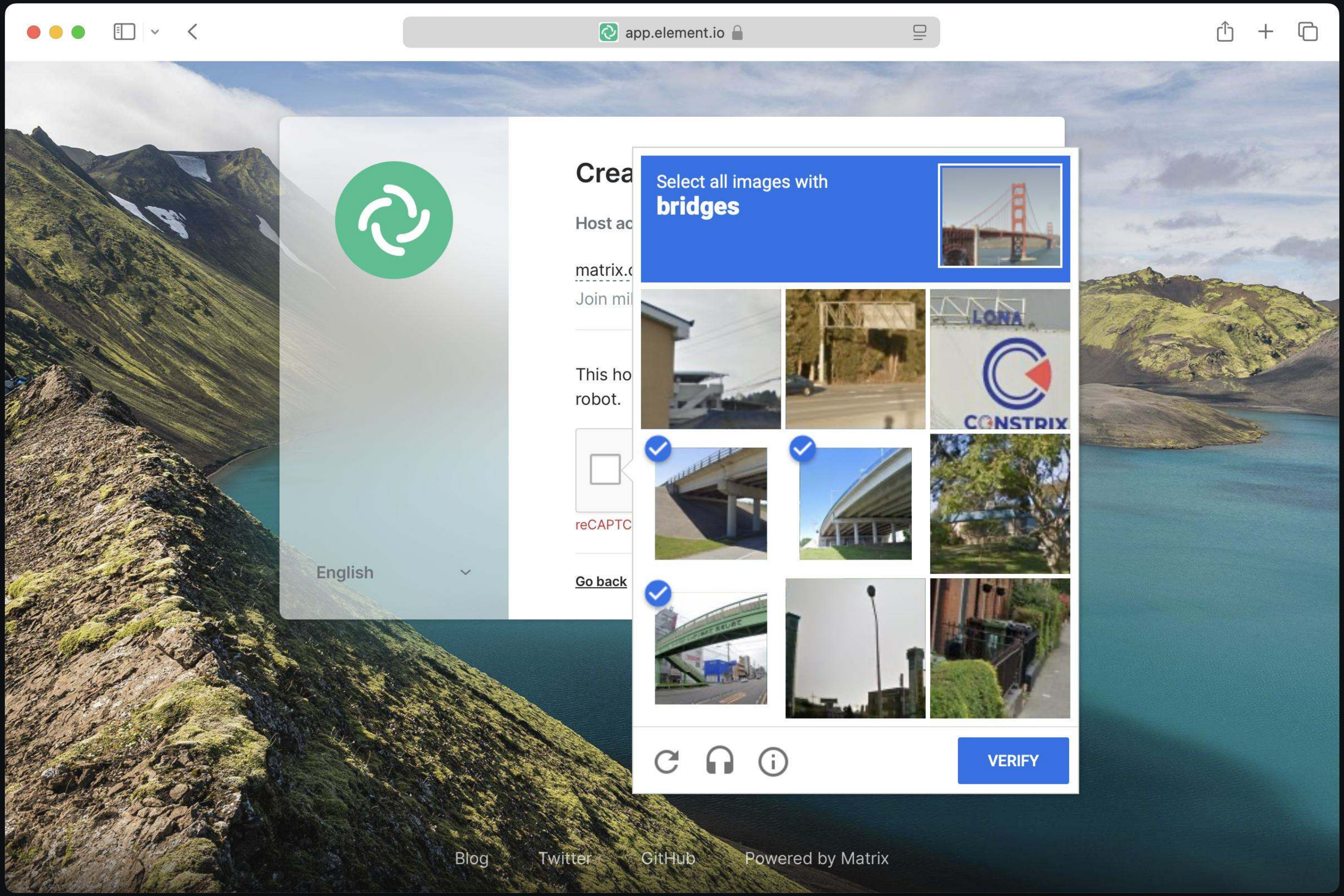
Host ac

matrix.c

Join mil

This ho
robot.

reCAPTC



app.element.io

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matrix.c

Join mil

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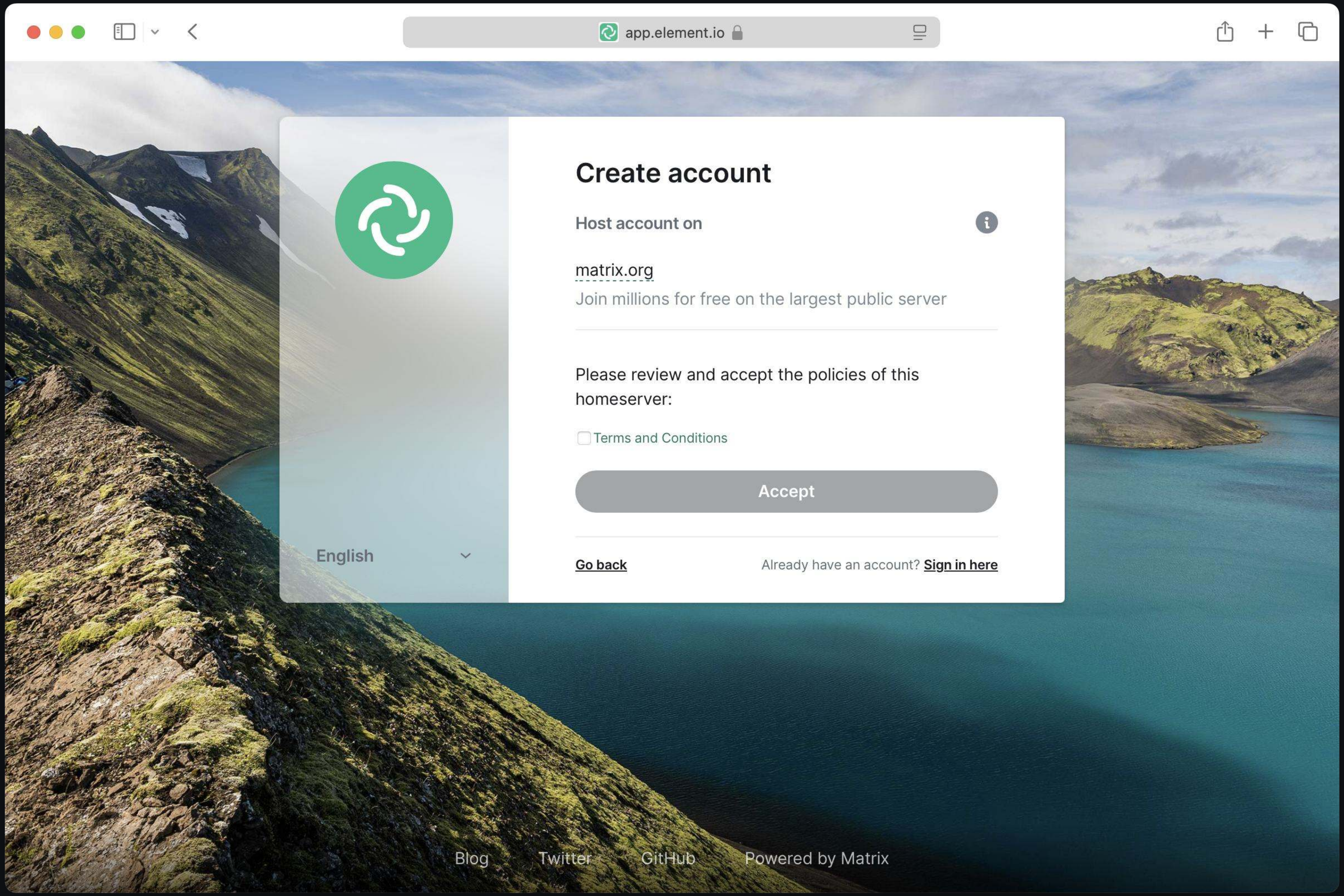
reCAPTC

Go back

Select all images with **bridges**



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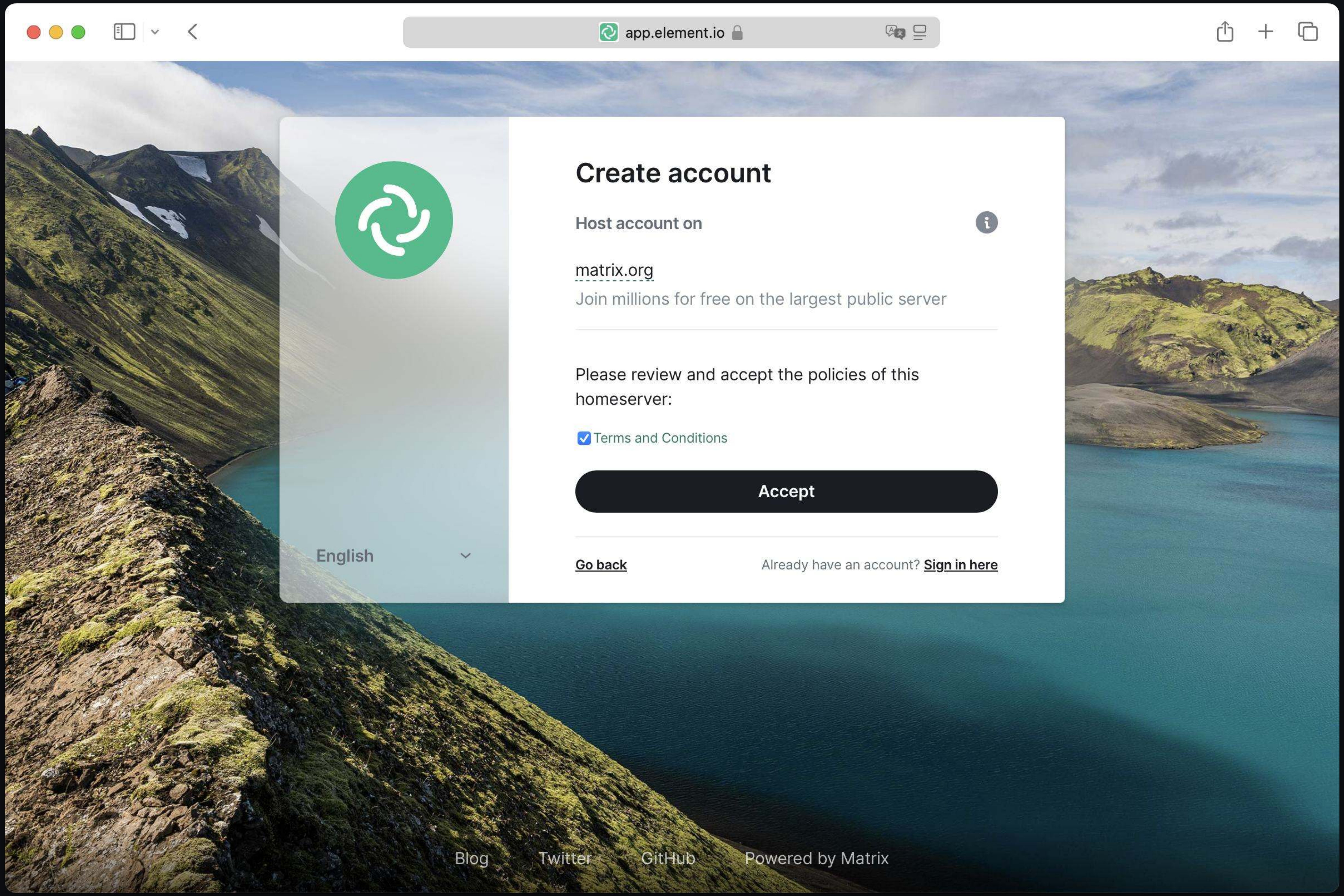
Please review and accept the policies of this homeserver:

□ Terms and Conditions

Already have an account? Sign in here



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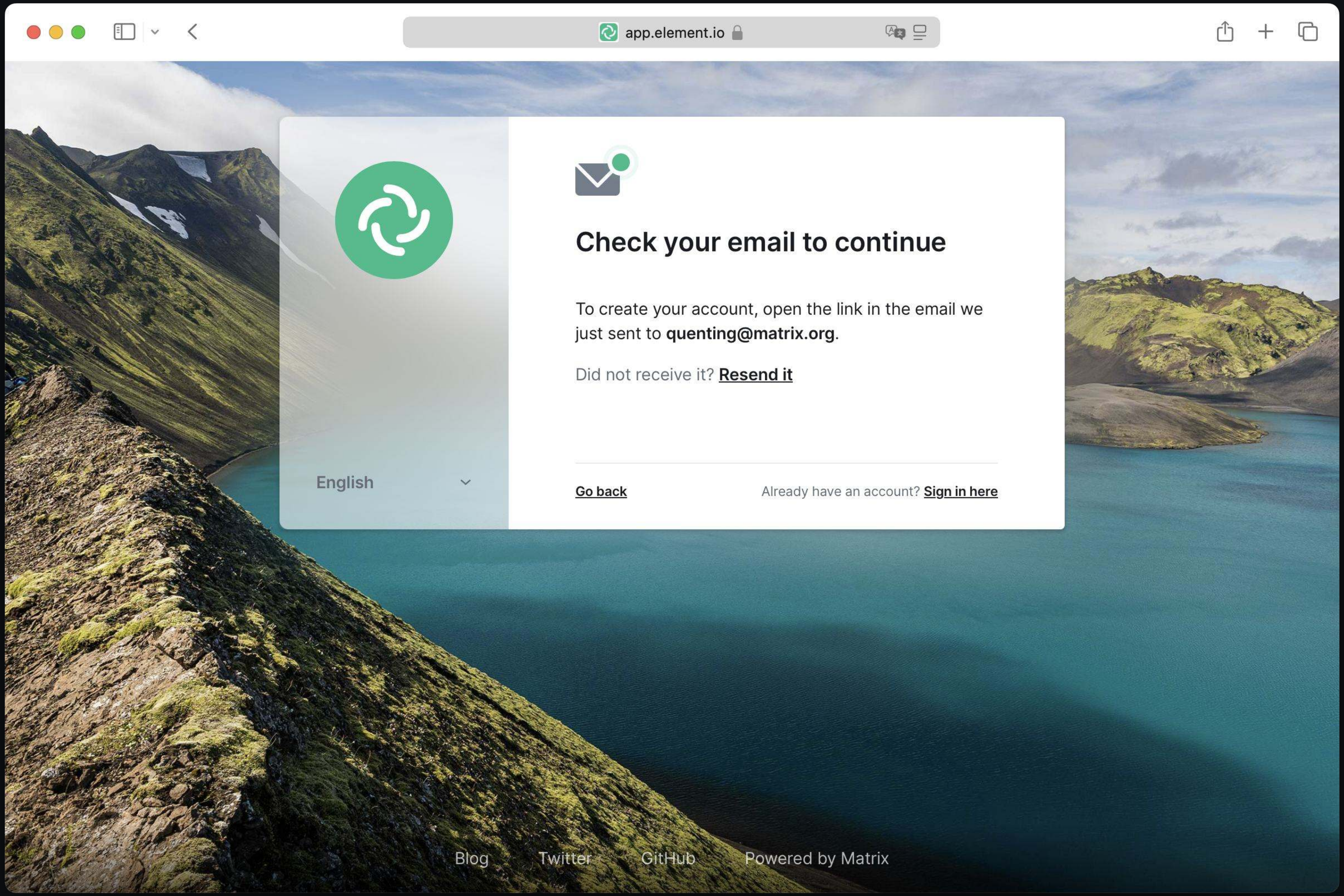
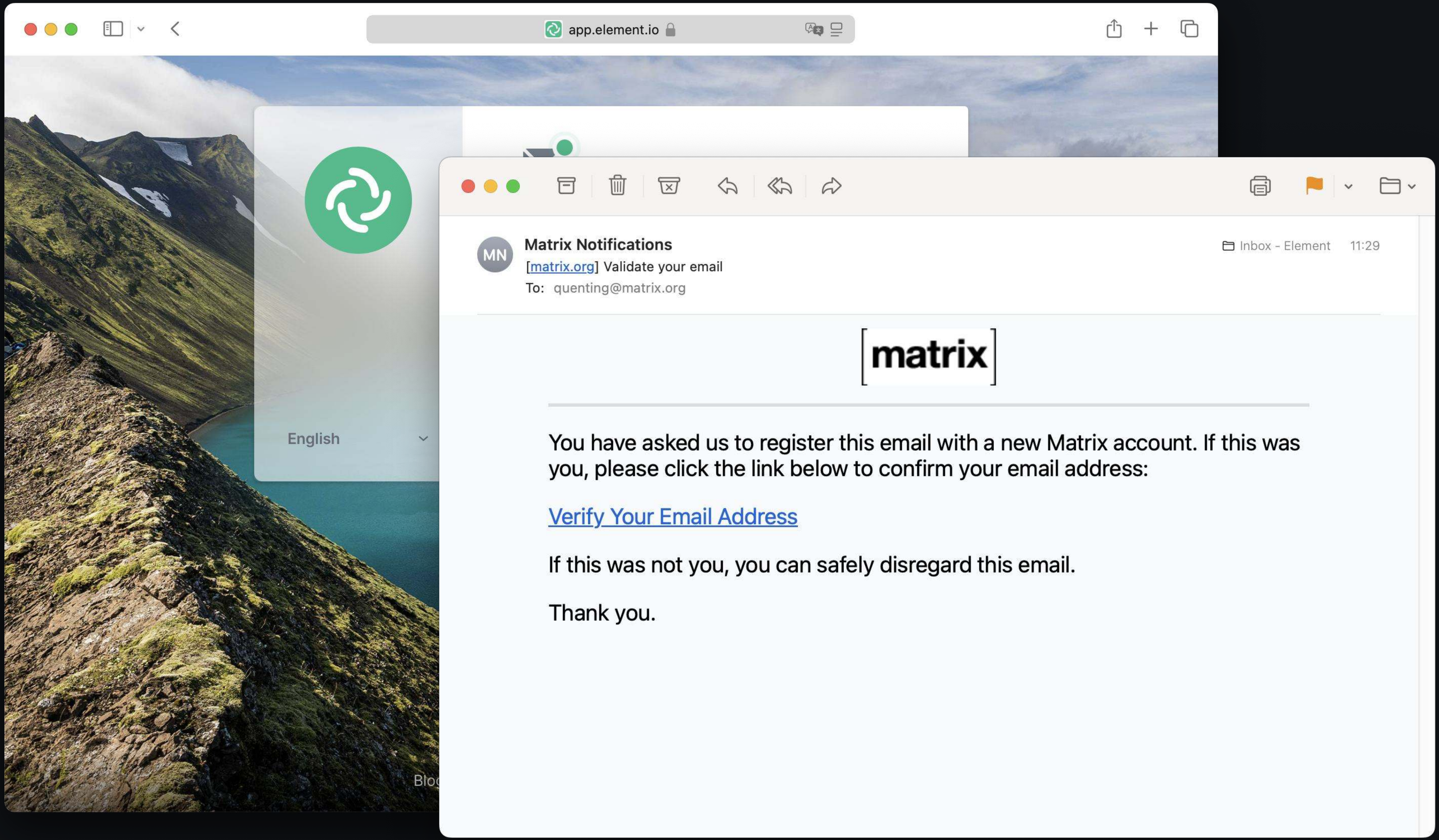


Check your email to continue

To create your account, open the link in the email we just sent to **quenting@matrix.org**.

Did not receive it? **Resend it**



MN

Matrix Notifications

[matrix.org] Validate your email

To: quenting@matrix.org

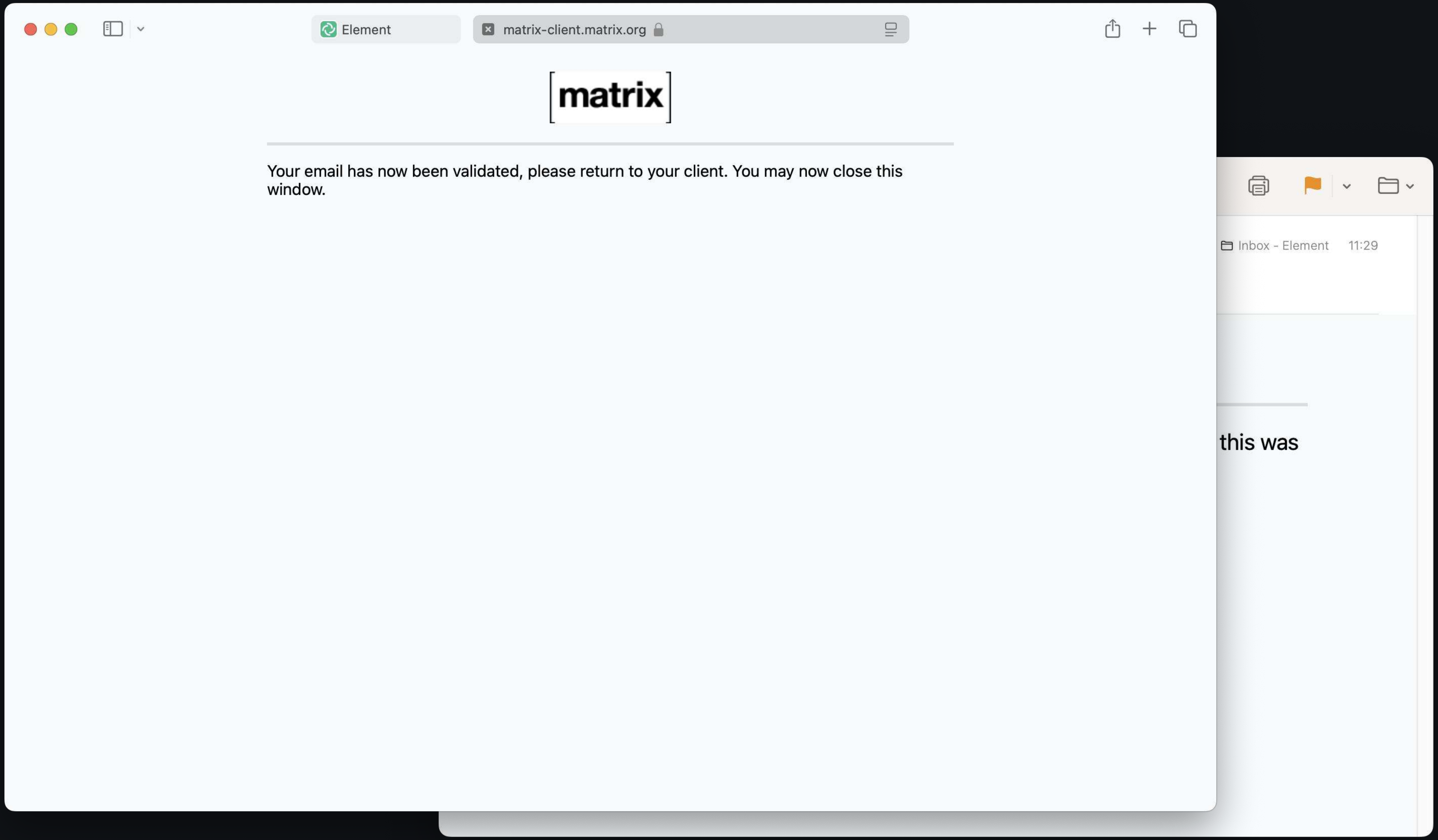
[matrix]

You have asked us to register this email with a new Matrix account. If this was you, please click the link below to confirm your email address:

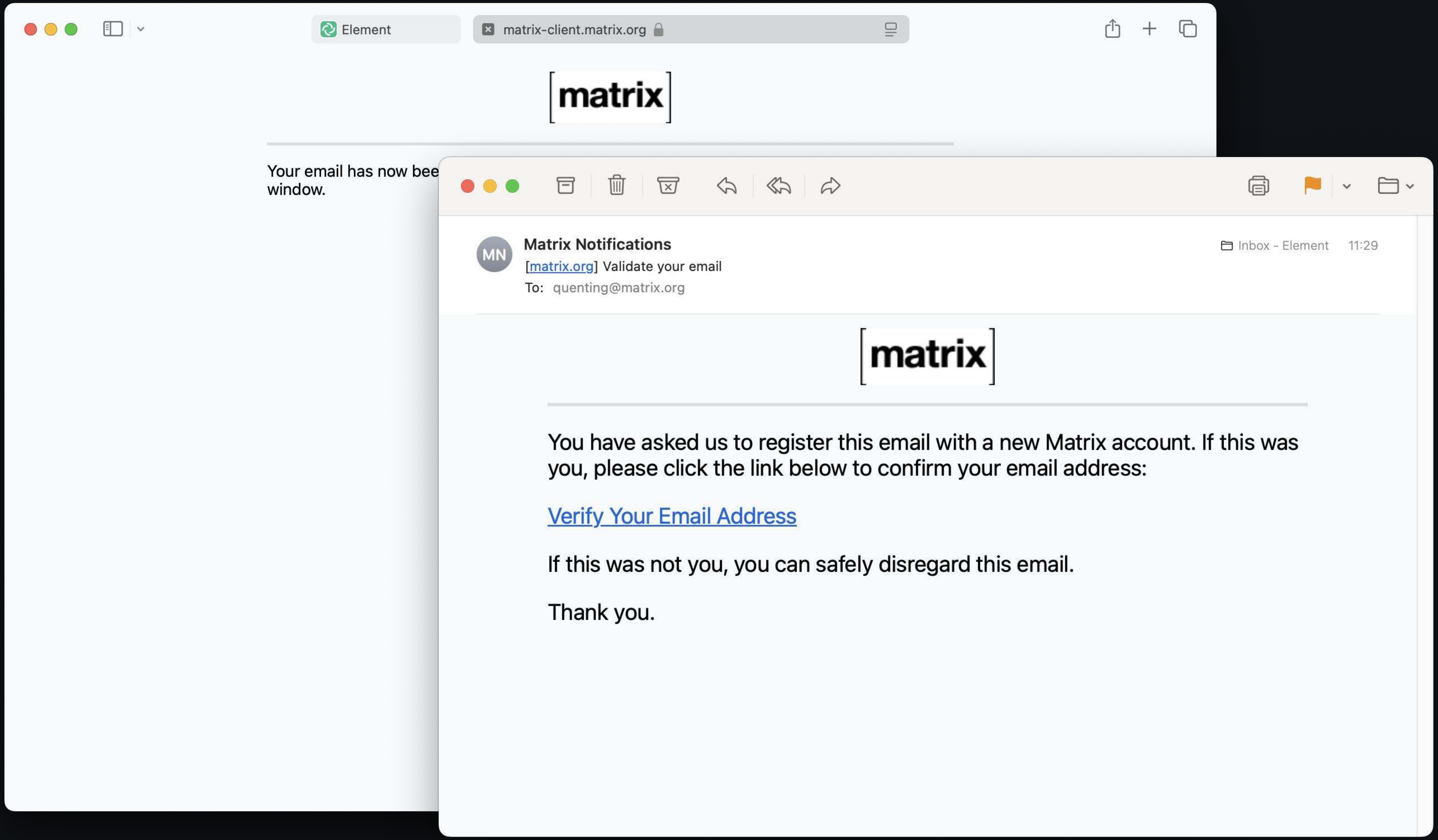
Verify Your Email Address

If this was not you, you can safely disregard this email.

Thank you.



Your email has now been validated, please return to your client. You may now close this window.



Your email has now bee
window.

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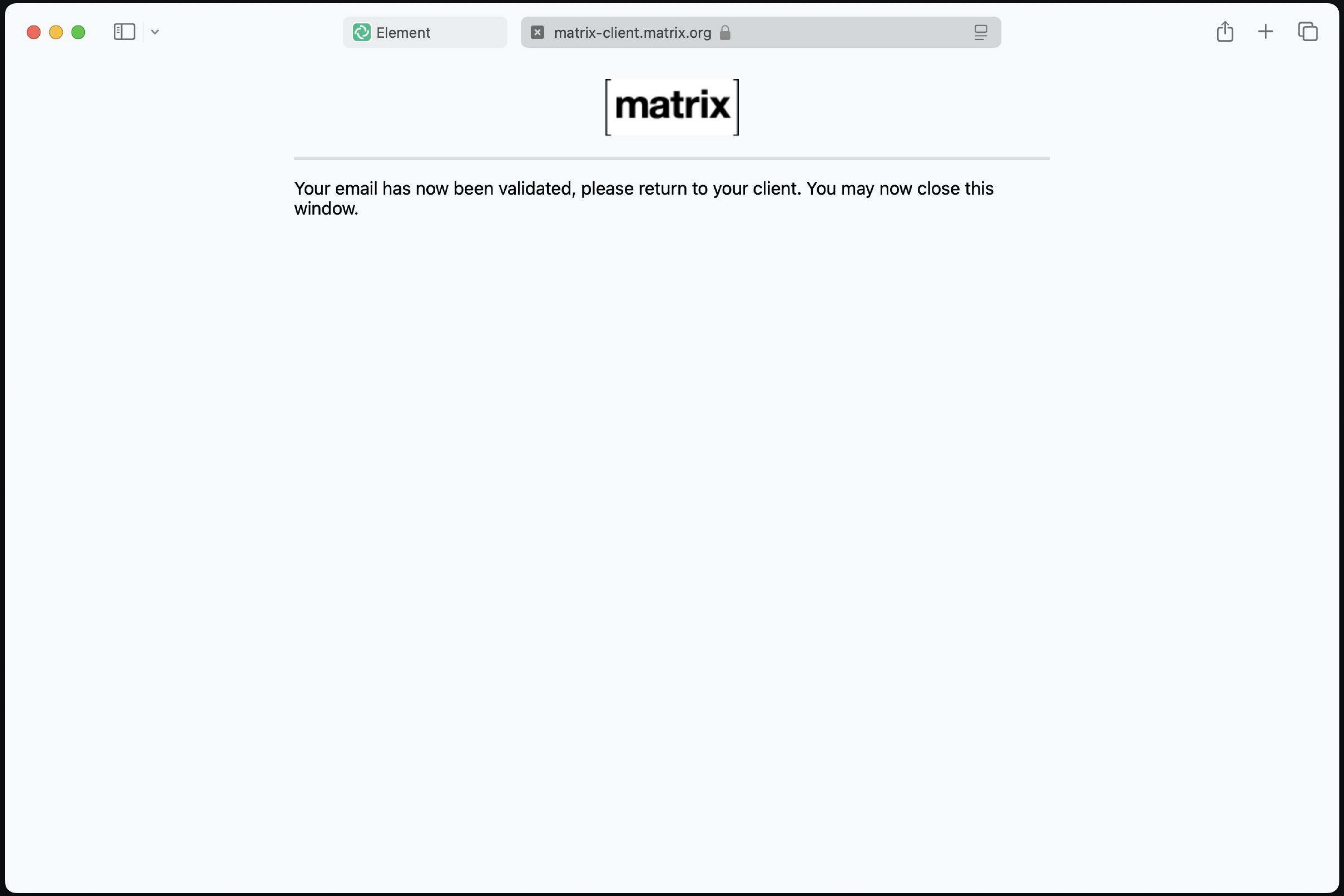
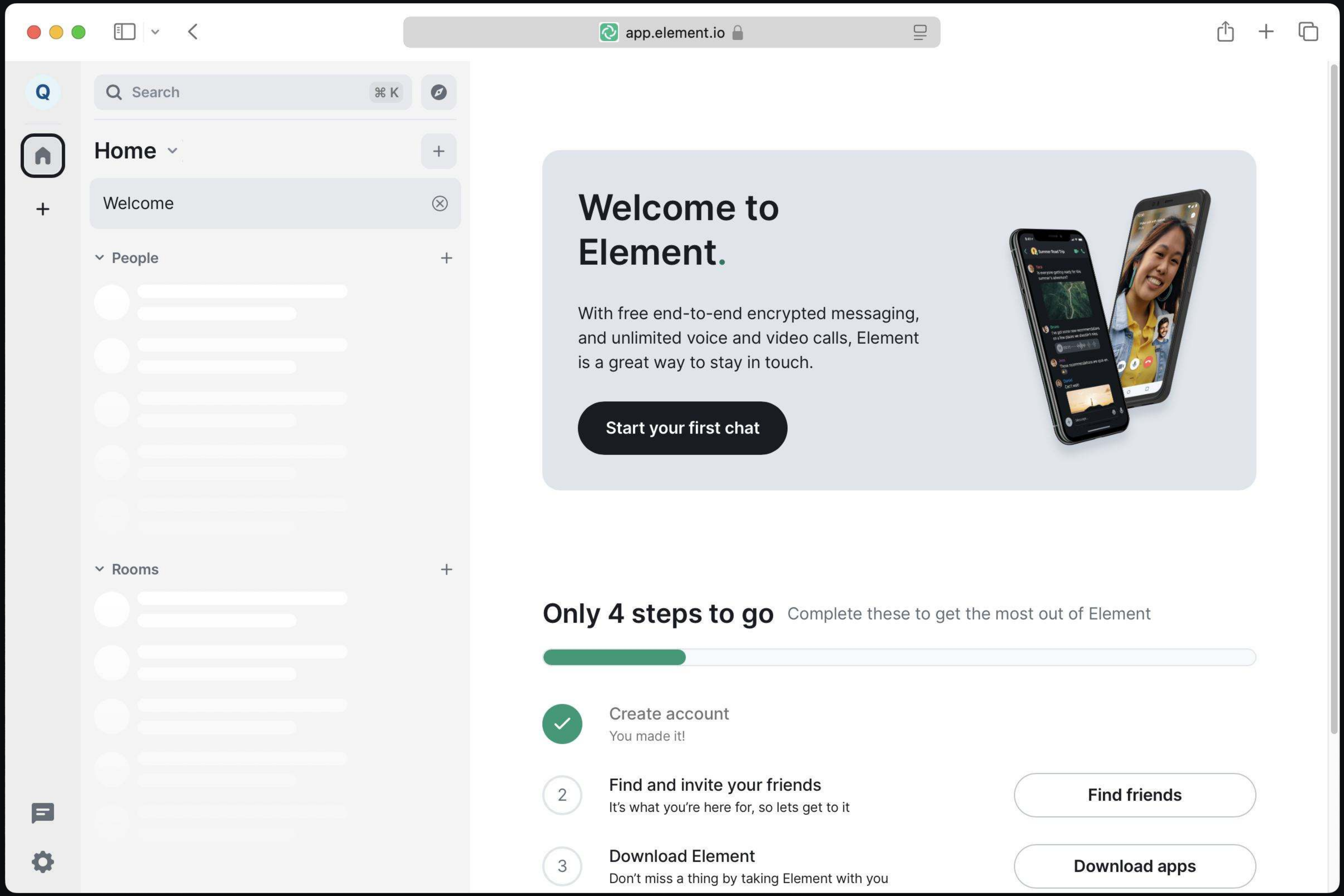


Your email has now been validated, please return to your client. You may now close this window.



## Welcome to Element.

With free end-to-end encrypted messaging, and unlimited voice and video calls, Element is a great way to stay in touch.

Only 4 steps to go Complete these to get the most out of Element

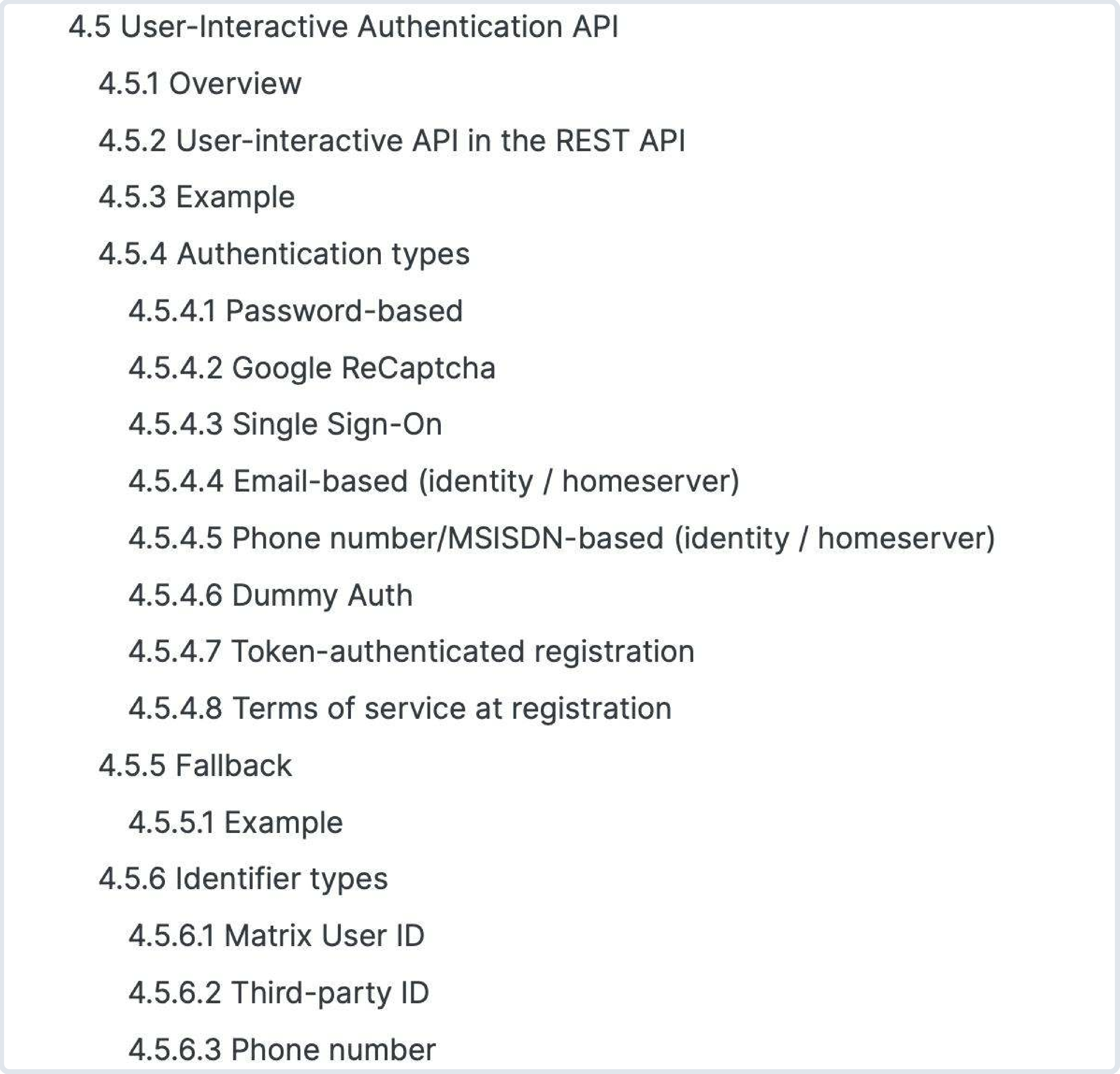
✓ Create account
You made it!

2 Find and invite your friends
It's what you're here for, so lets get to it

3 Download Element
Don't miss a thing by taking Element with you

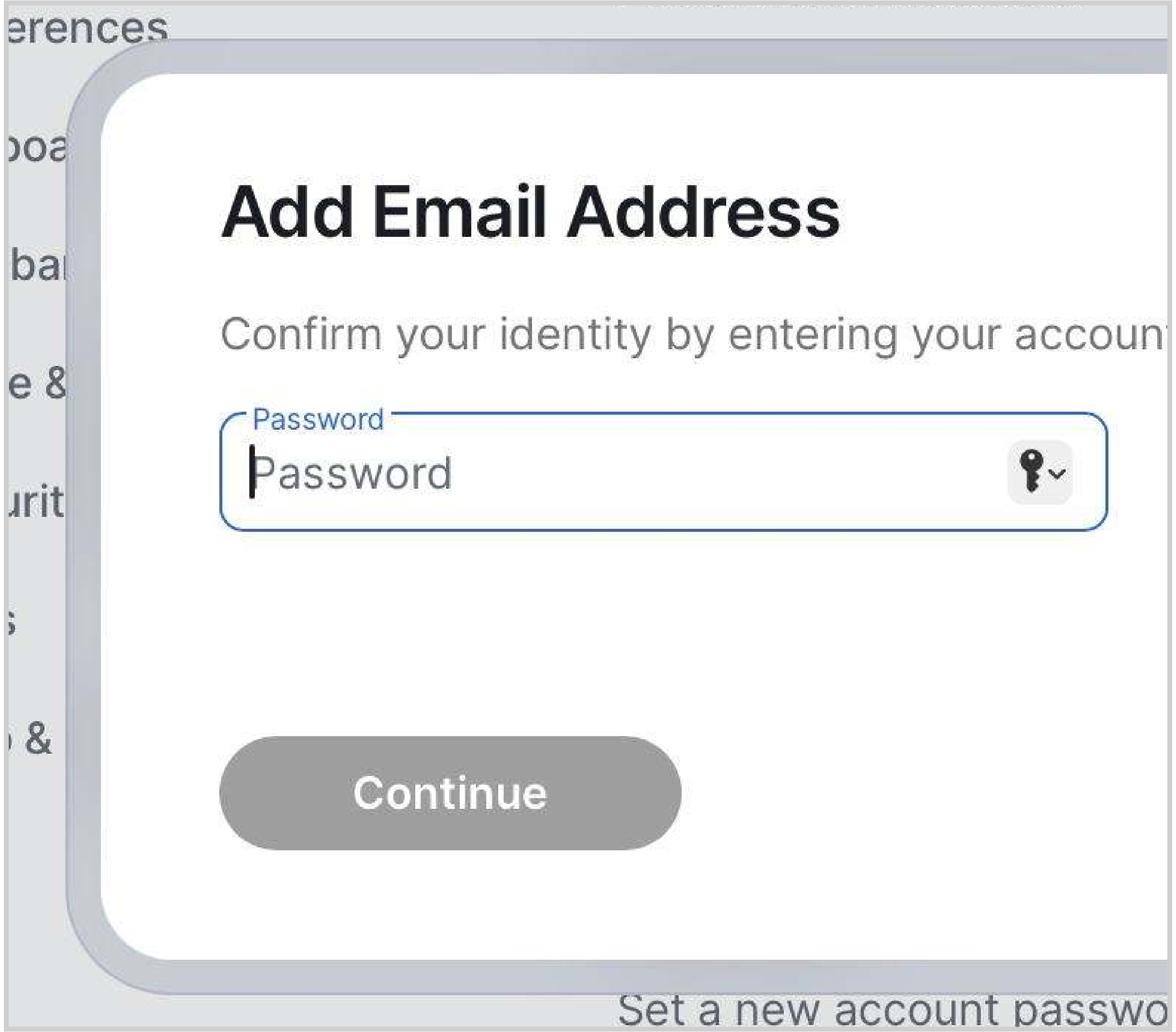
# How did we end up here?

A gentle introduction to
User-Interactive Authentication



- 4.5 User-Interactive Authentication API
  - 4.5.1 Overview
  - 4.5.2 User-interactive API in the REST API
  - 4.5.3 Example
  - 4.5.4 Authentication types
    - 4.5.4.1 Password-based
    - 4.5.4.2 Google ReCaptcha
    - 4.5.4.3 Single Sign-On
    - 4.5.4.4 Email-based (identity / homeserver)
    - 4.5.4.5 Phone number/MSISDN-based (identity / homeserver)
    - 4.5.4.6 Dummy Auth
    - 4.5.4.7 Token-authenticated registration
    - 4.5.4.8 Terms of service at registration
  - 4.5.5 Fallback
    - 4.5.5.1 Example
  - 4.5.6 Identifier types
    - 4.5.6.1 Matrix User ID
    - 4.5.6.2 Third-party ID
    - 4.5.6.3 Phone number

# A gentle introduction to User-Interactive Authentication



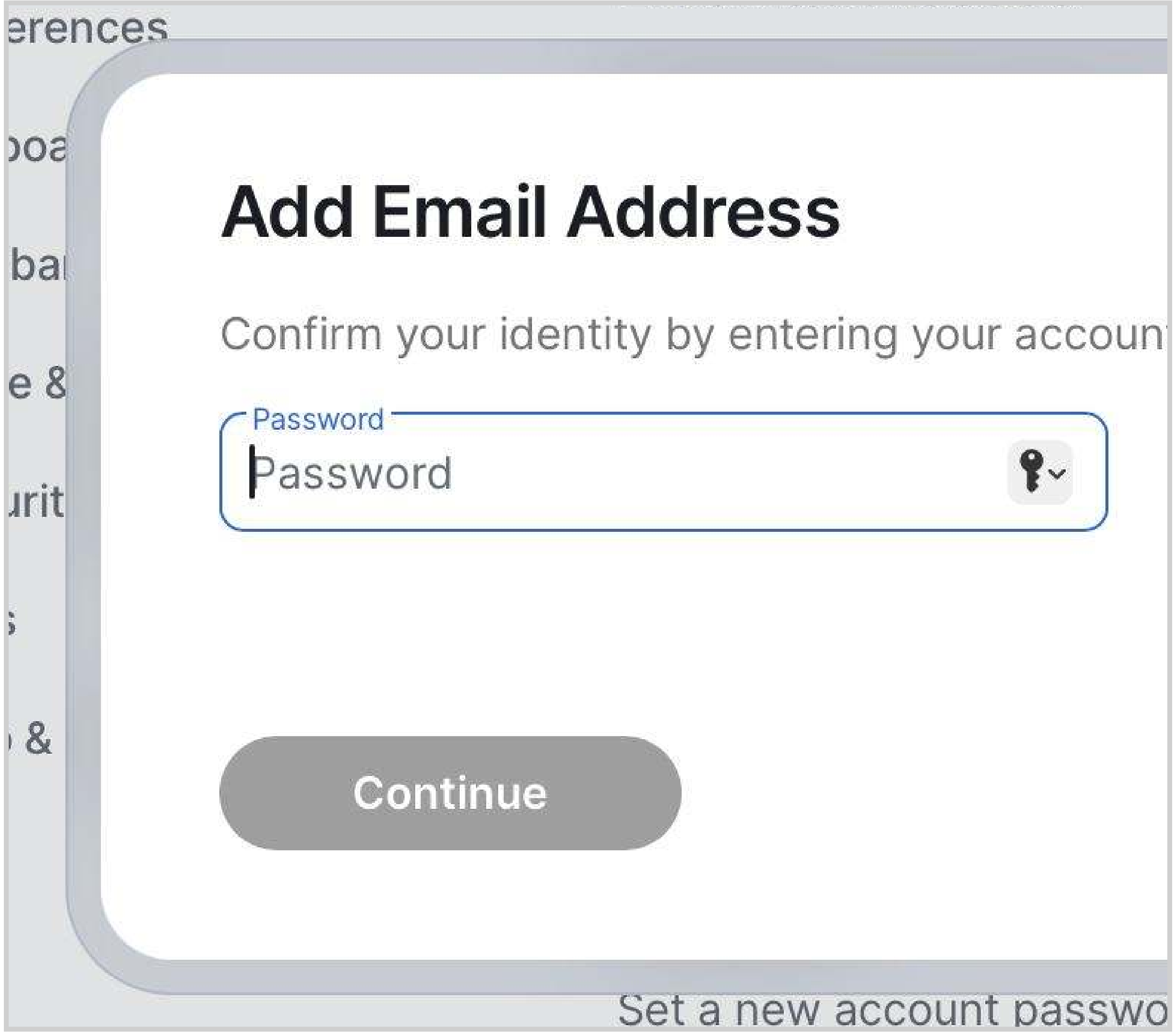
Add Email Address

Confirm your identity by entering your accoun

## Protect sensitive operations

Account deactivation, password change, adding/removing an email-address, etc.

# A gentle introduction to User-Interactive Authentication



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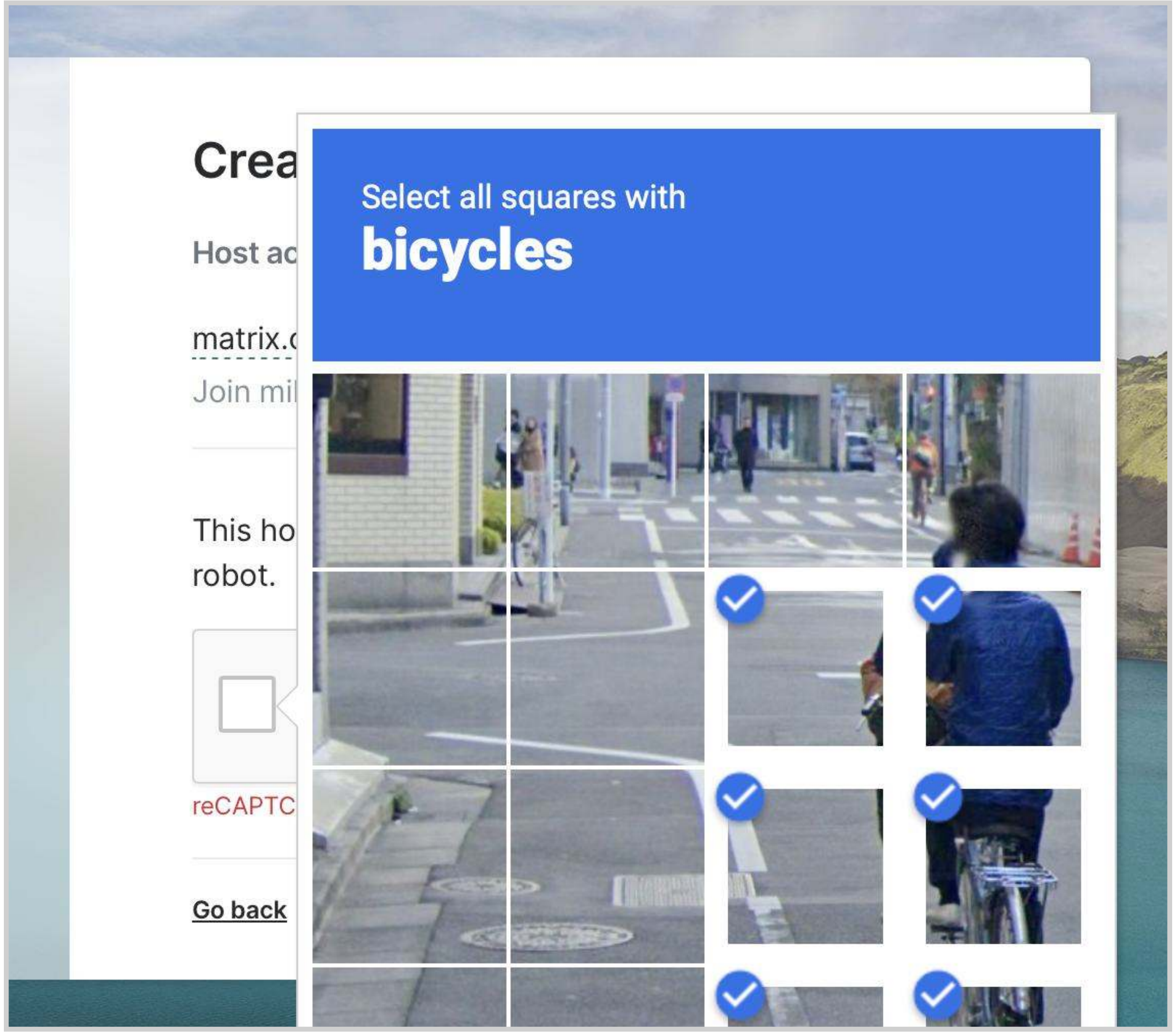
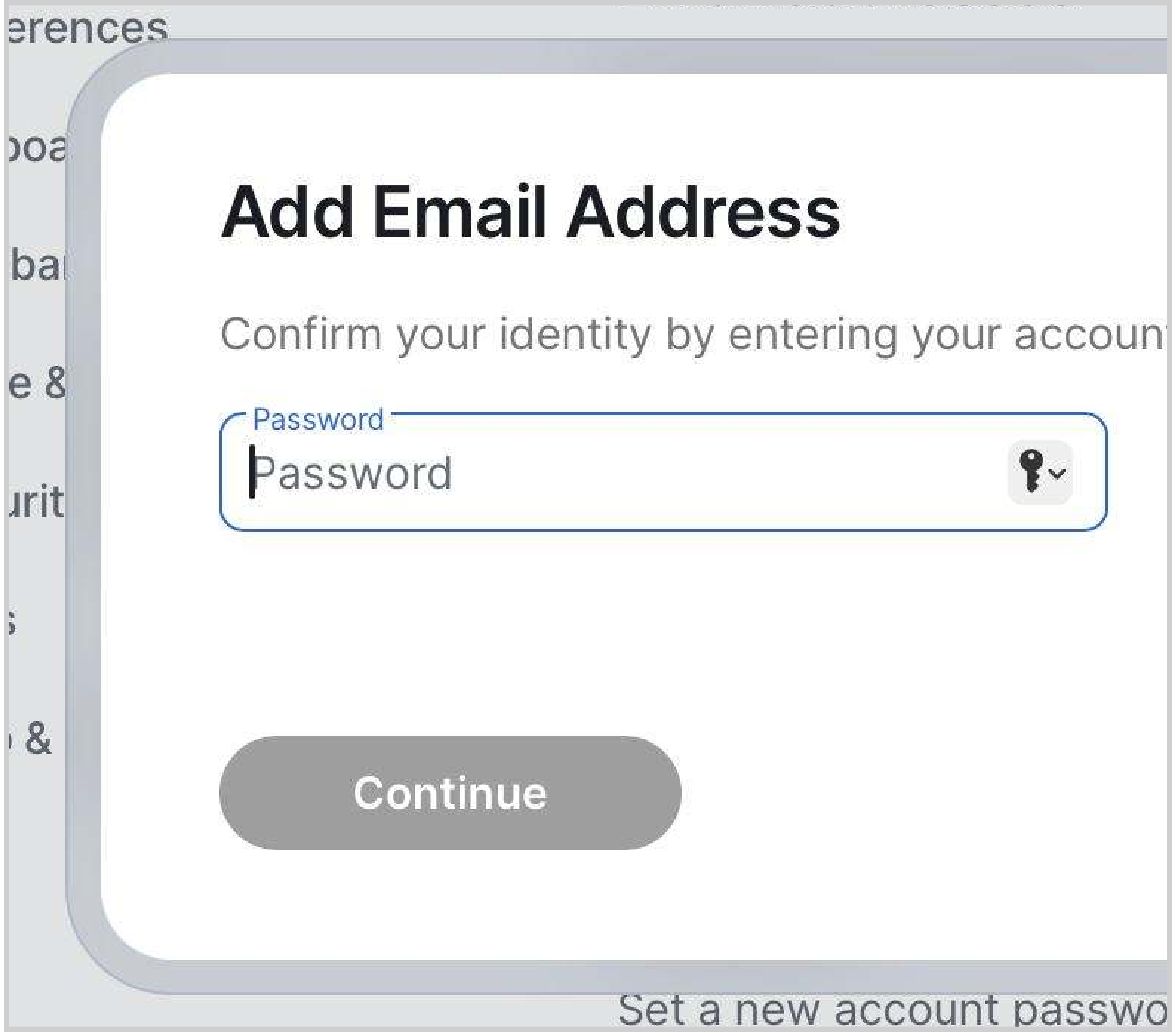


Select all squares with
**bicycles**

## Multi-stage authentication

Dynamically ask for multiple steps

# A gentle introduction to User-Interactive Authentication



Add Email Address

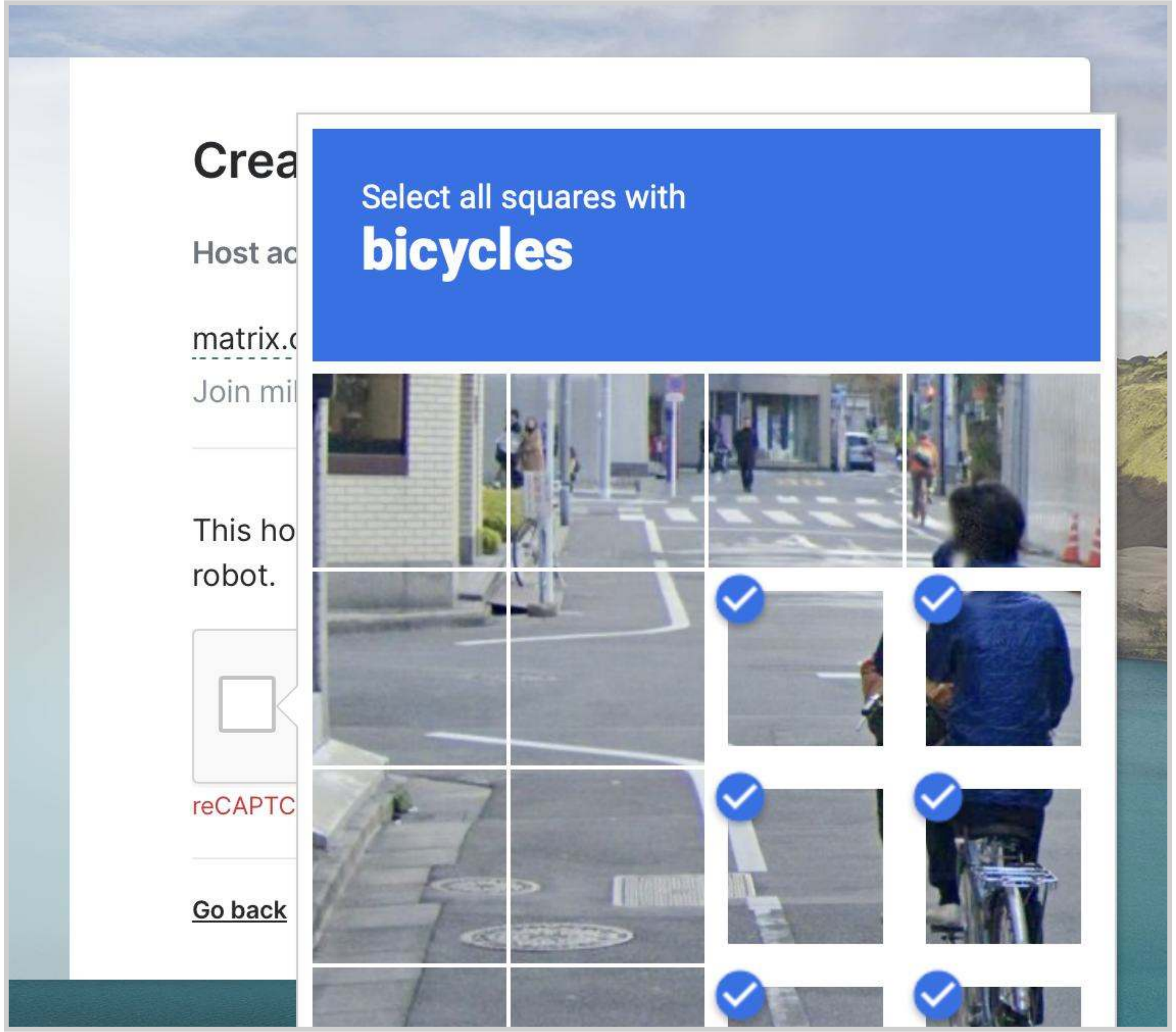
Confirm your identity by entering your accoun

Password: Password

Set a new account passwo

## Protect sensitive operations

Account deactivation, password change, adding/removing an email-address, etc.



Crea

Host ac

matrix.c

Join mil

This ho robot.

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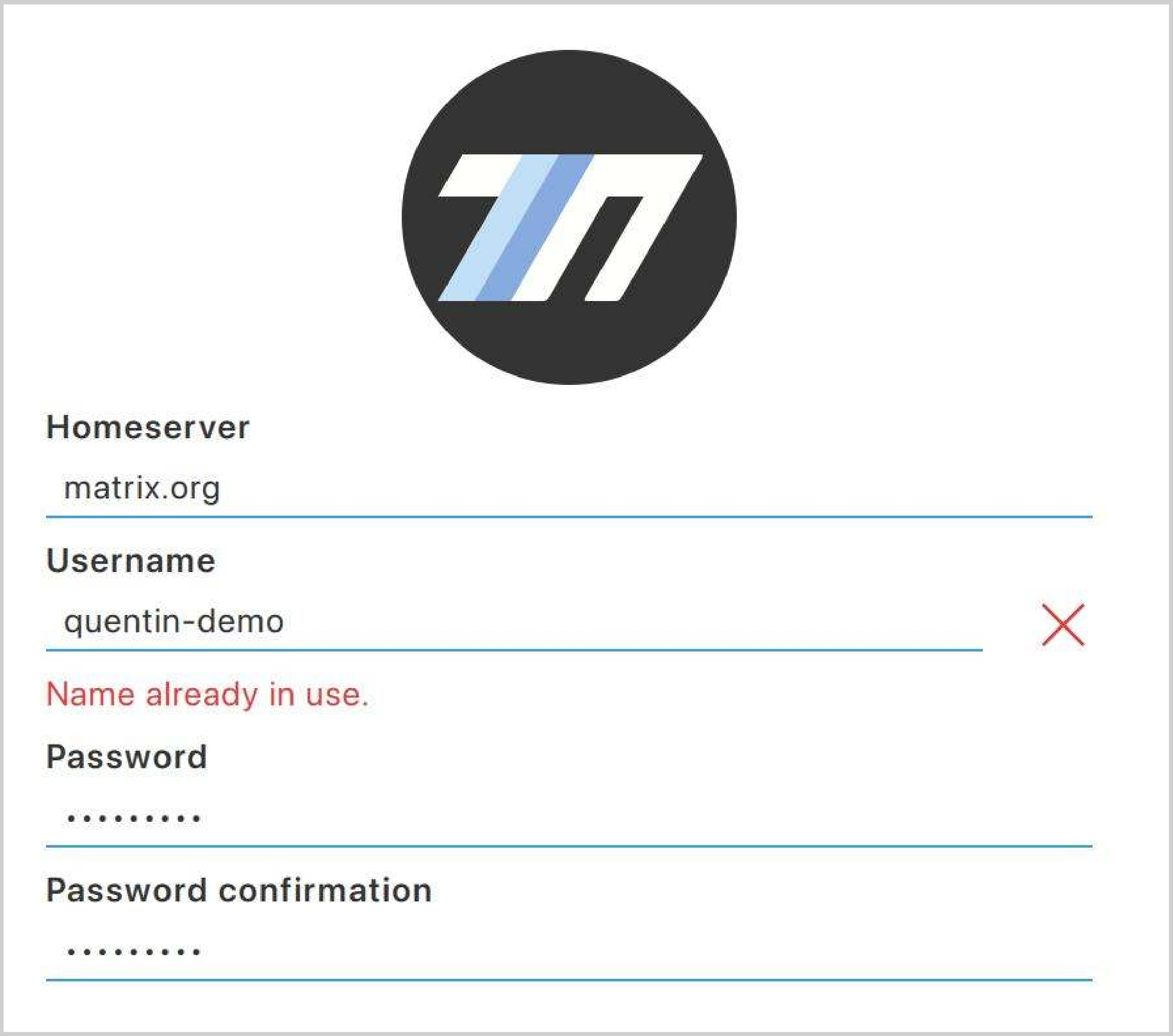


Homeserver: matrix.org

Username: quentin-demo

Name already in use.

Password: .........

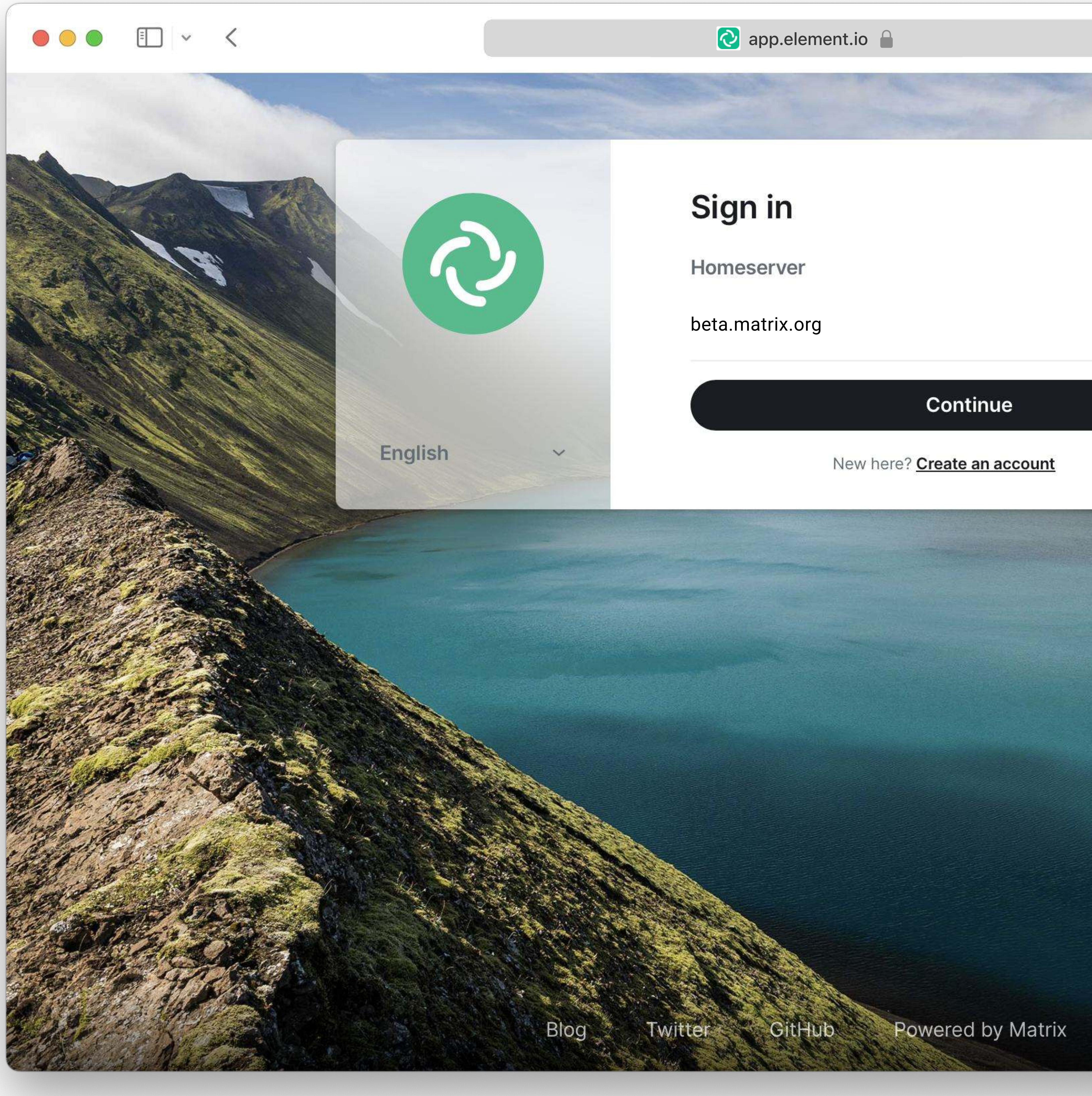
Password confirmation: .........

## Client-native user interface

Each step is ideally implemented within the client, in a streamlined UI

# Same thing, with the new authentication stack

I'm a new Matrix user,
registering a new account in Element Web

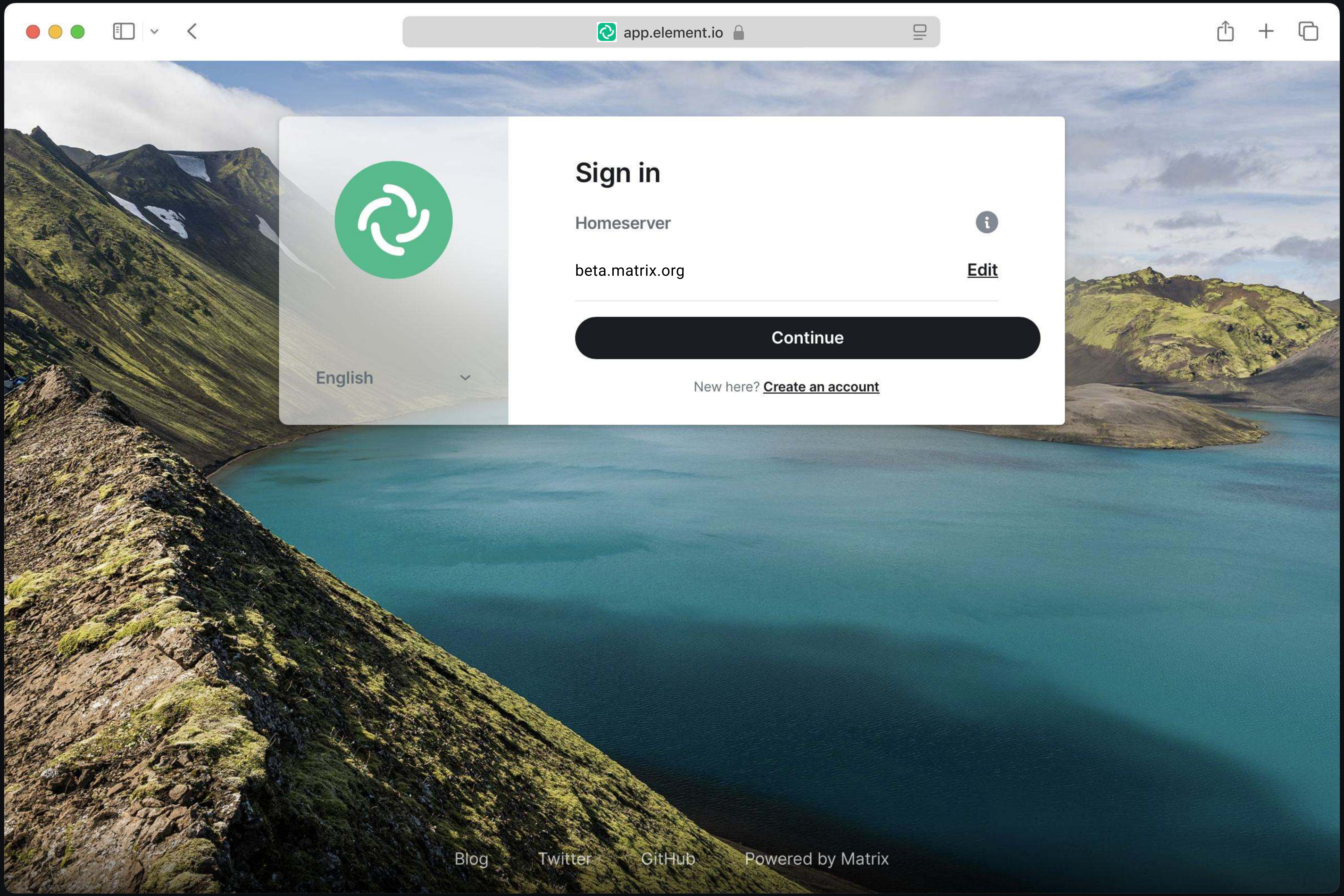


app.element.io

## Sign in

Homeserver

beta.matrix.org



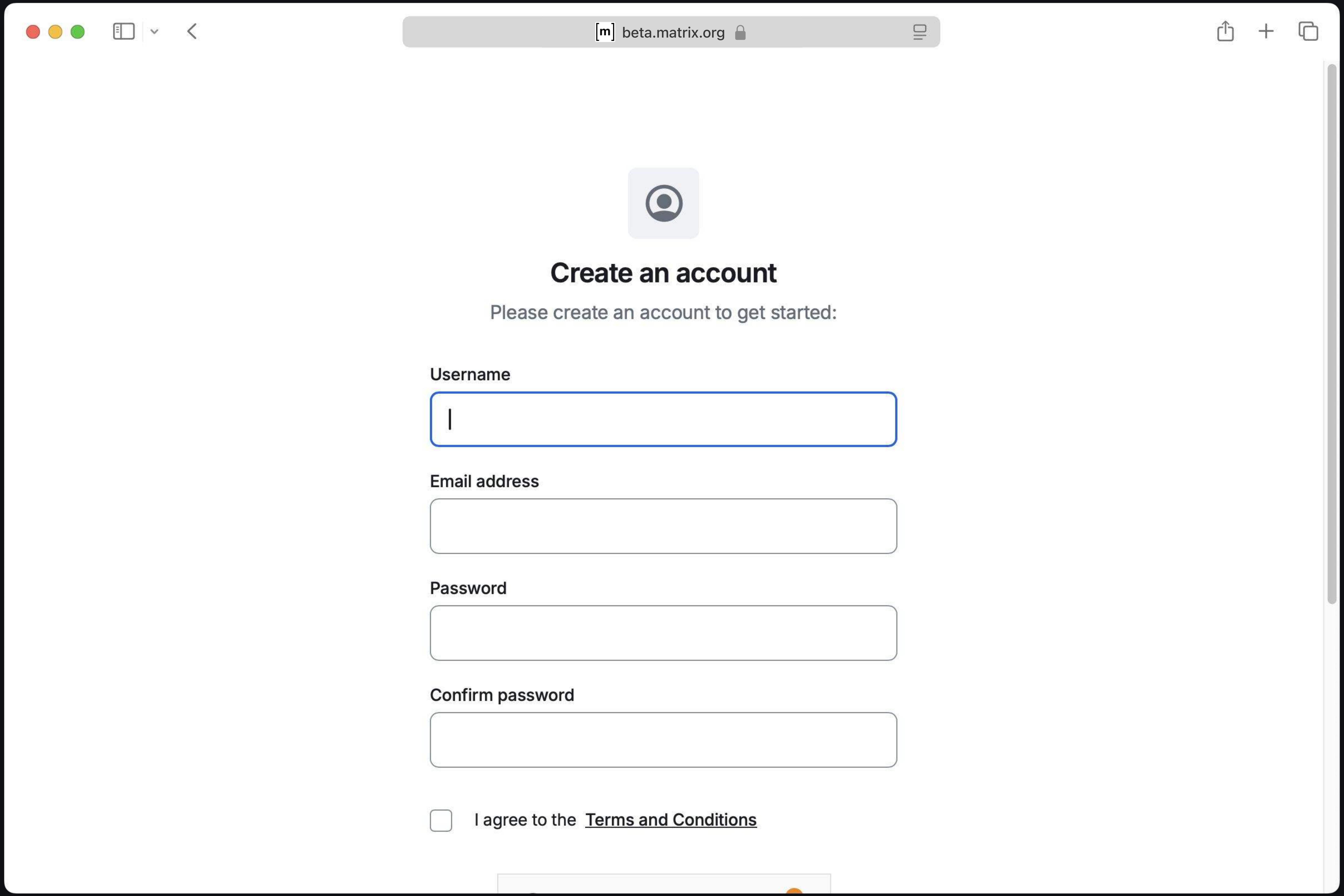
app.element.io

## Sign in

Homeserver

beta.matrix.org

New here? Create an account



Create an account

Please create an account to get started:

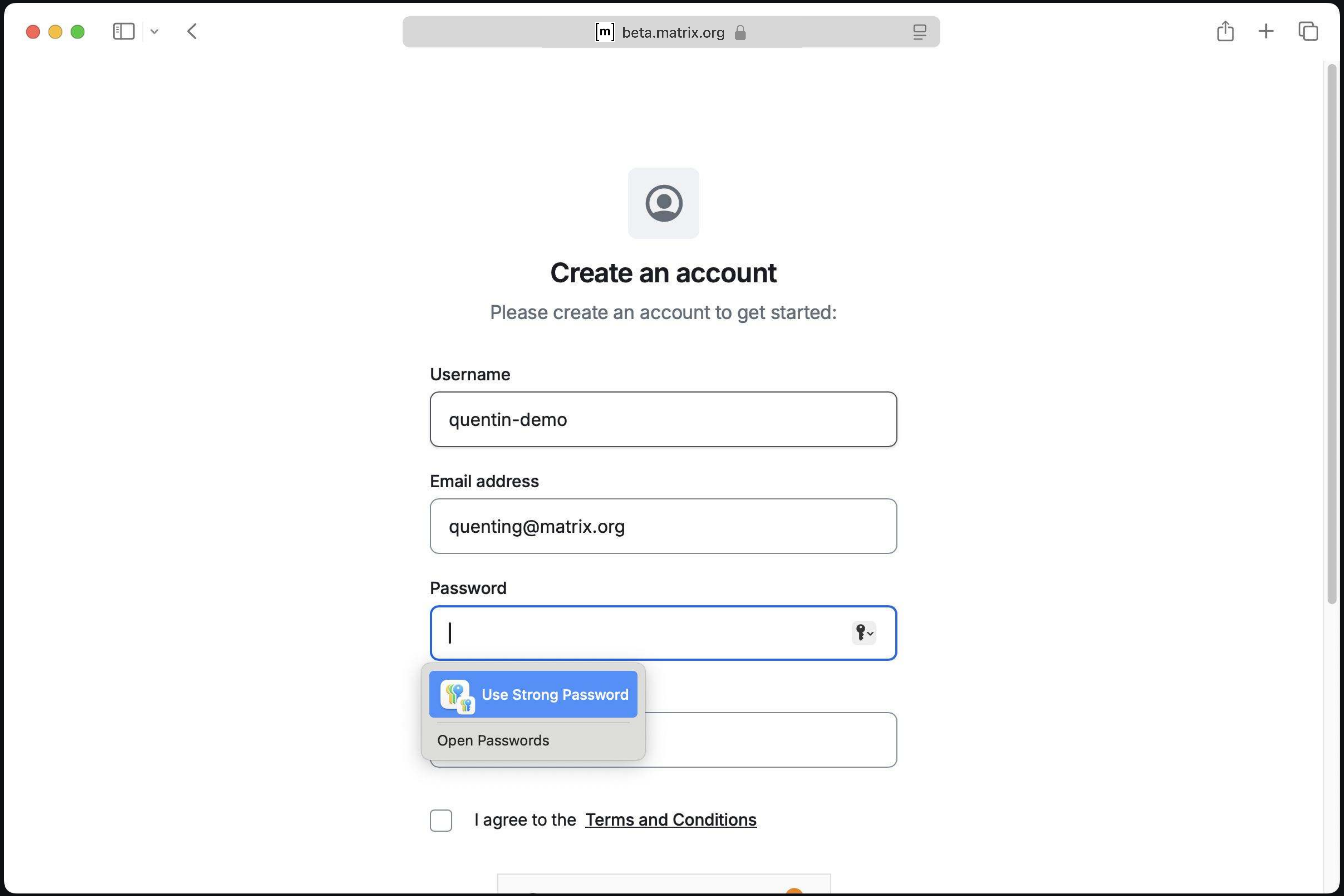
Username

Email address

Password

Confirm password

□ I agree to the Terms and Conditions



## Create an account

Please create an account to get started:

Username

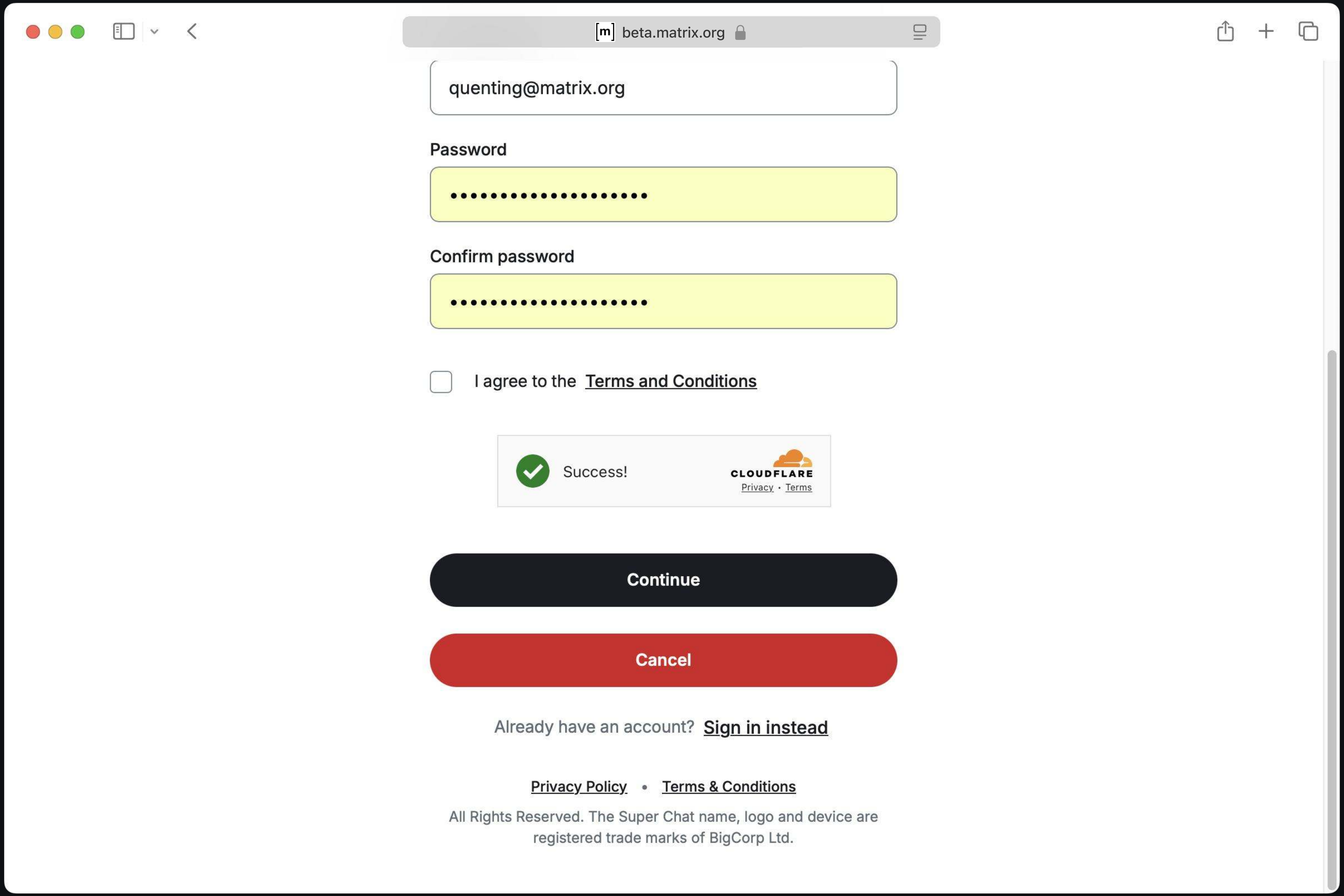
quentin-demo

Email address

quenting@matrix.org

Password

□ I agree to the Terms and Conditions



beta.matrix.org

quenting@matrix.org

Password

•••••••••••••••••••

Confirm password

•••••••••••••••••••

□ I agree to the Terms and Conditions

Success!

Continue

Cancel

Already have an account? Sign in instead

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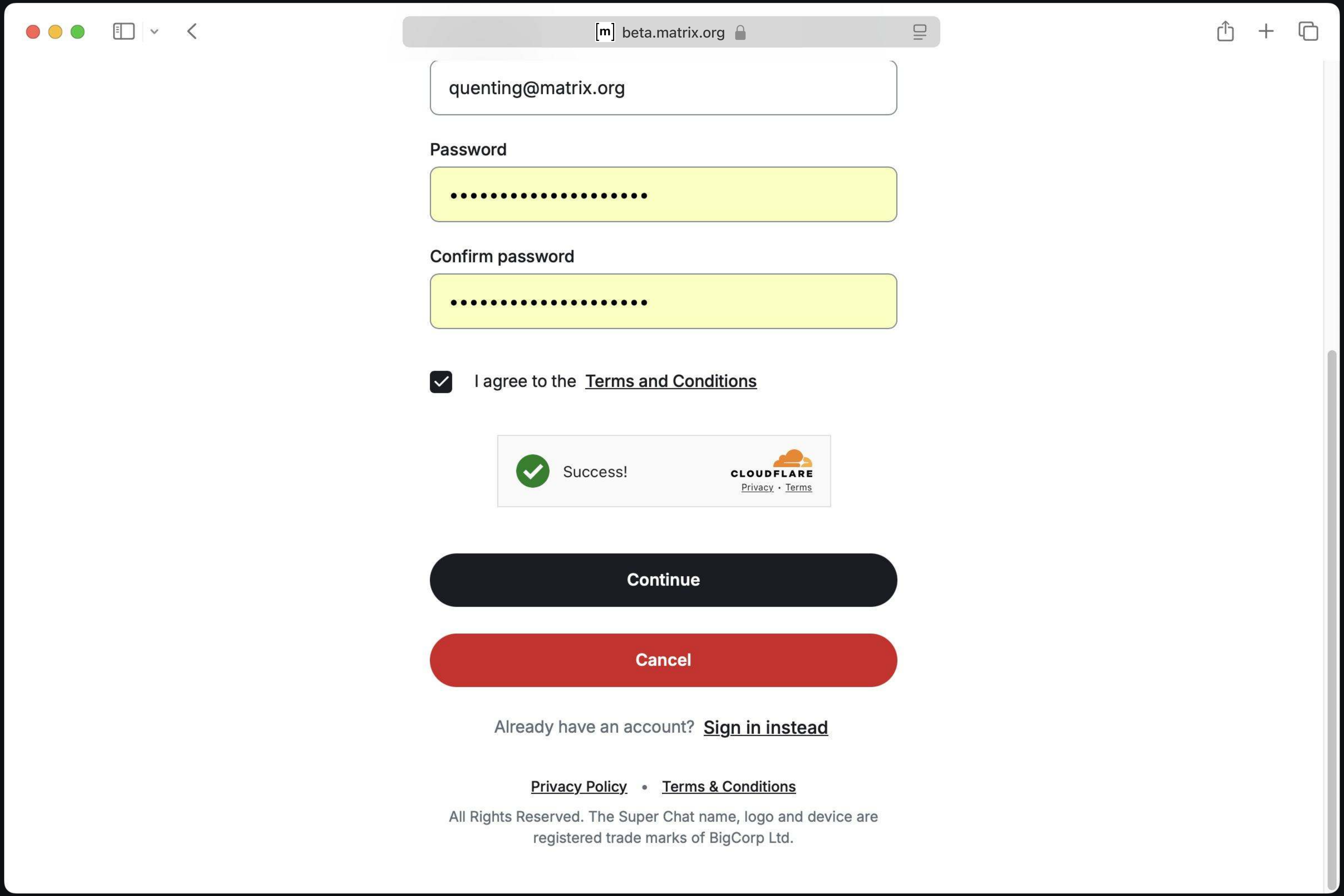

quenting@matrix.org

Password

••••••••••••••••••

Confirm password

••••••••••••••••••

☑ I agree to the Terms and Conditions

✓ Success!

Already have an account? Sign in instead

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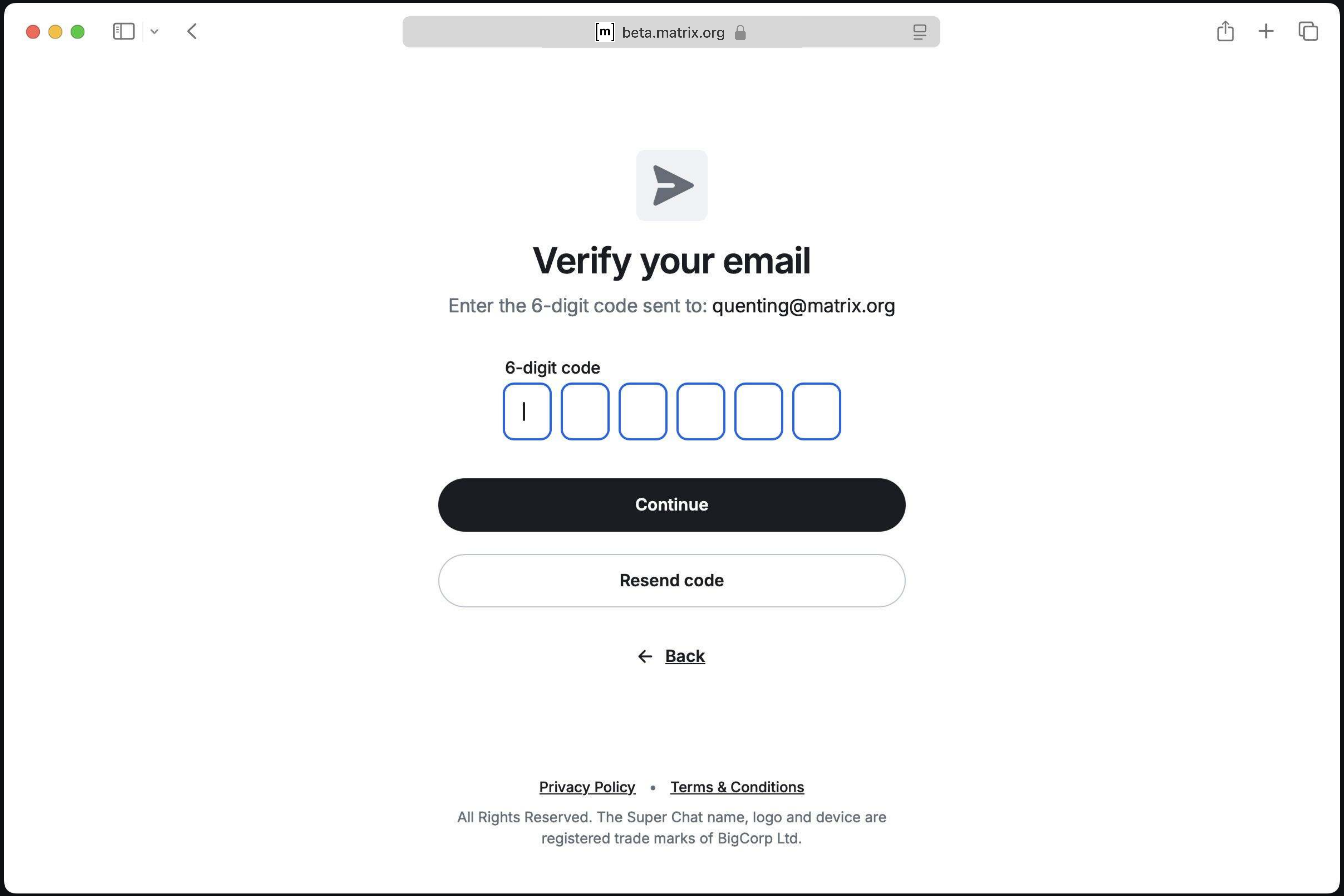

Verify your email

Enter the 6-digit code sent to: quenting@matrix.org

6-digit code

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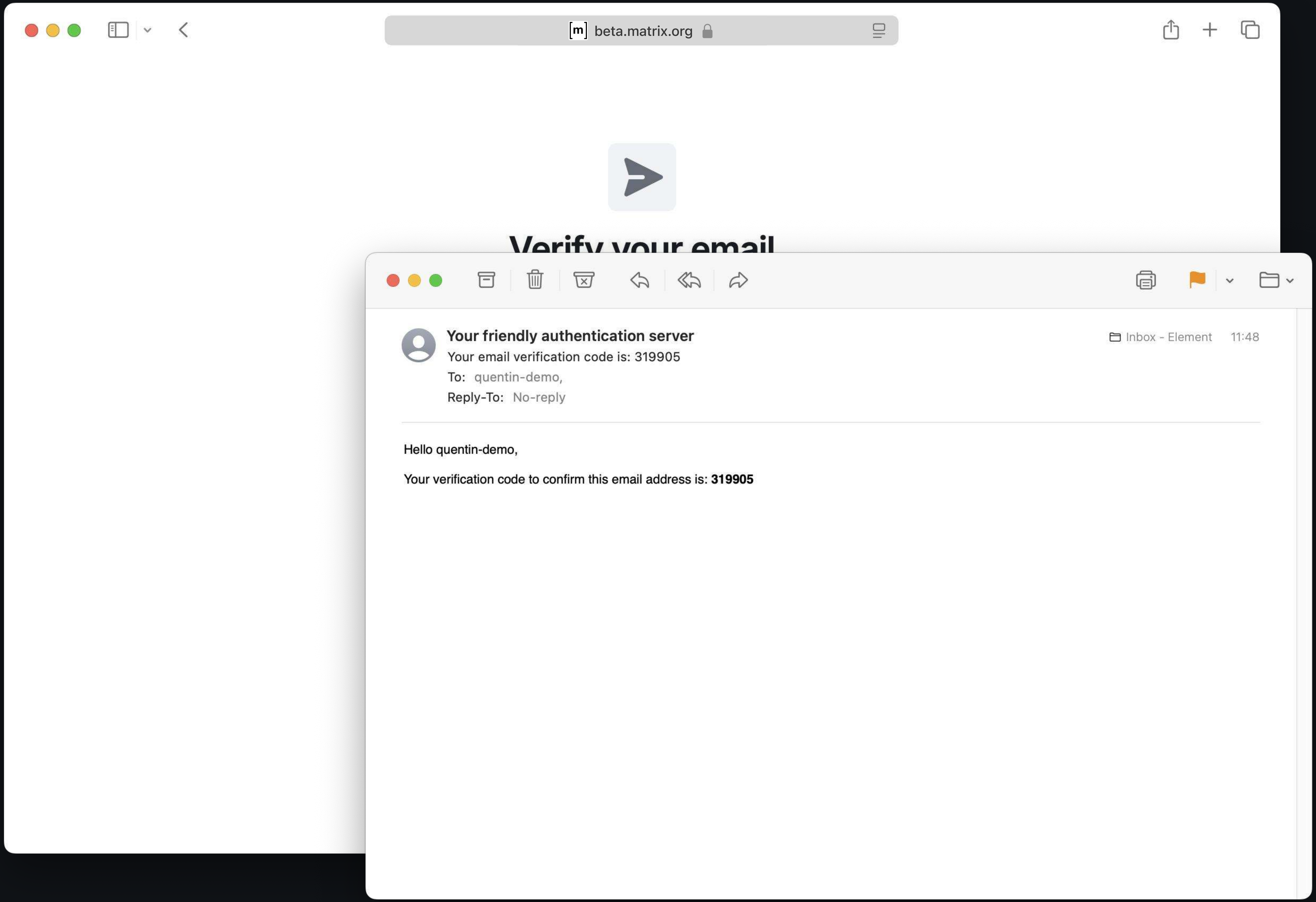


Verify your email

Your friendly authentication server

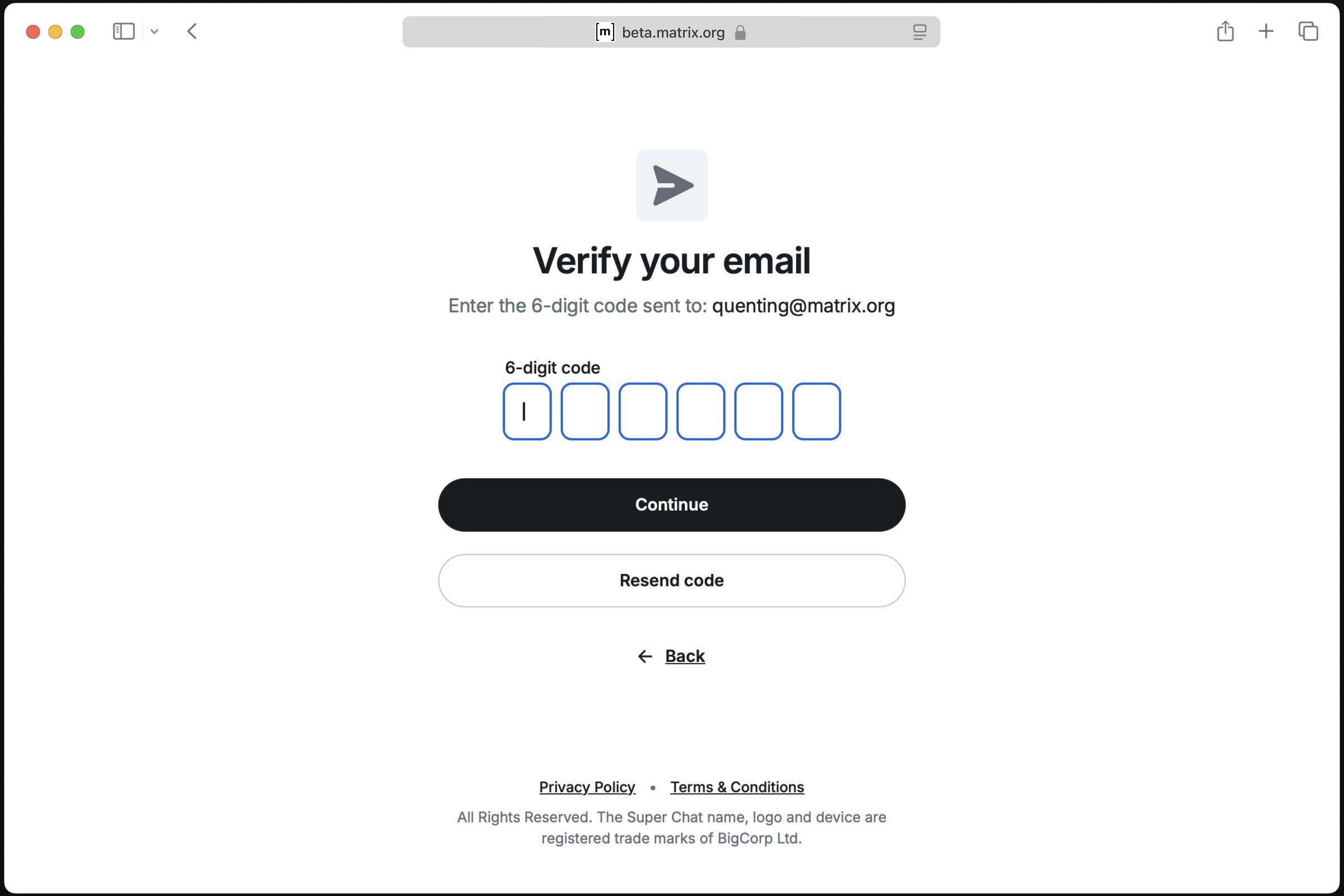
Your email verification code is: 319905

To: quentin-demo,

Reply-To: No-reply

Hello quentin-demo,

Your verification code to confirm this email address is: **319905**



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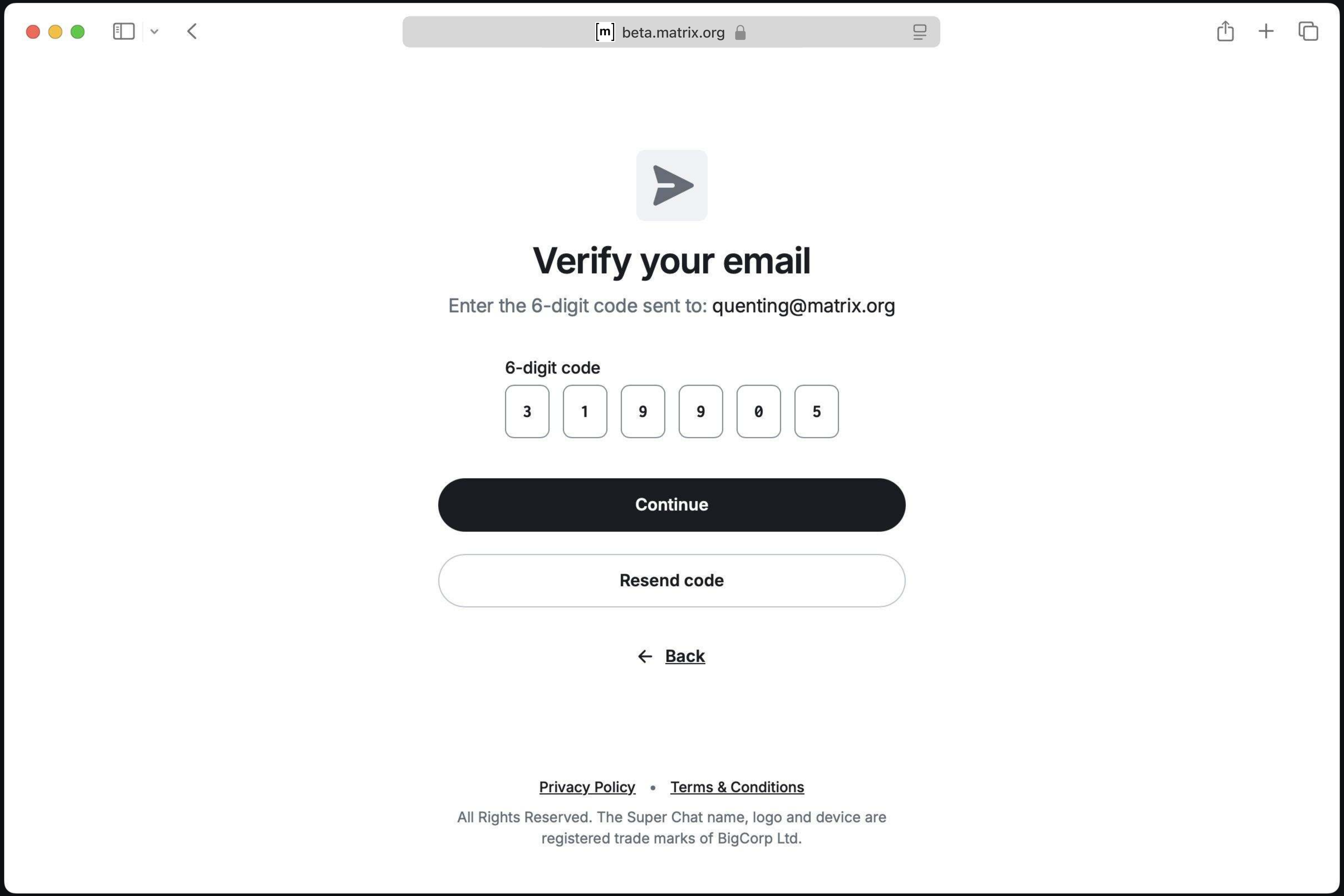

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Enter the 6-digit code sent to: quenting@matrix.org

6-digit code: 3 1 9 9 0 5

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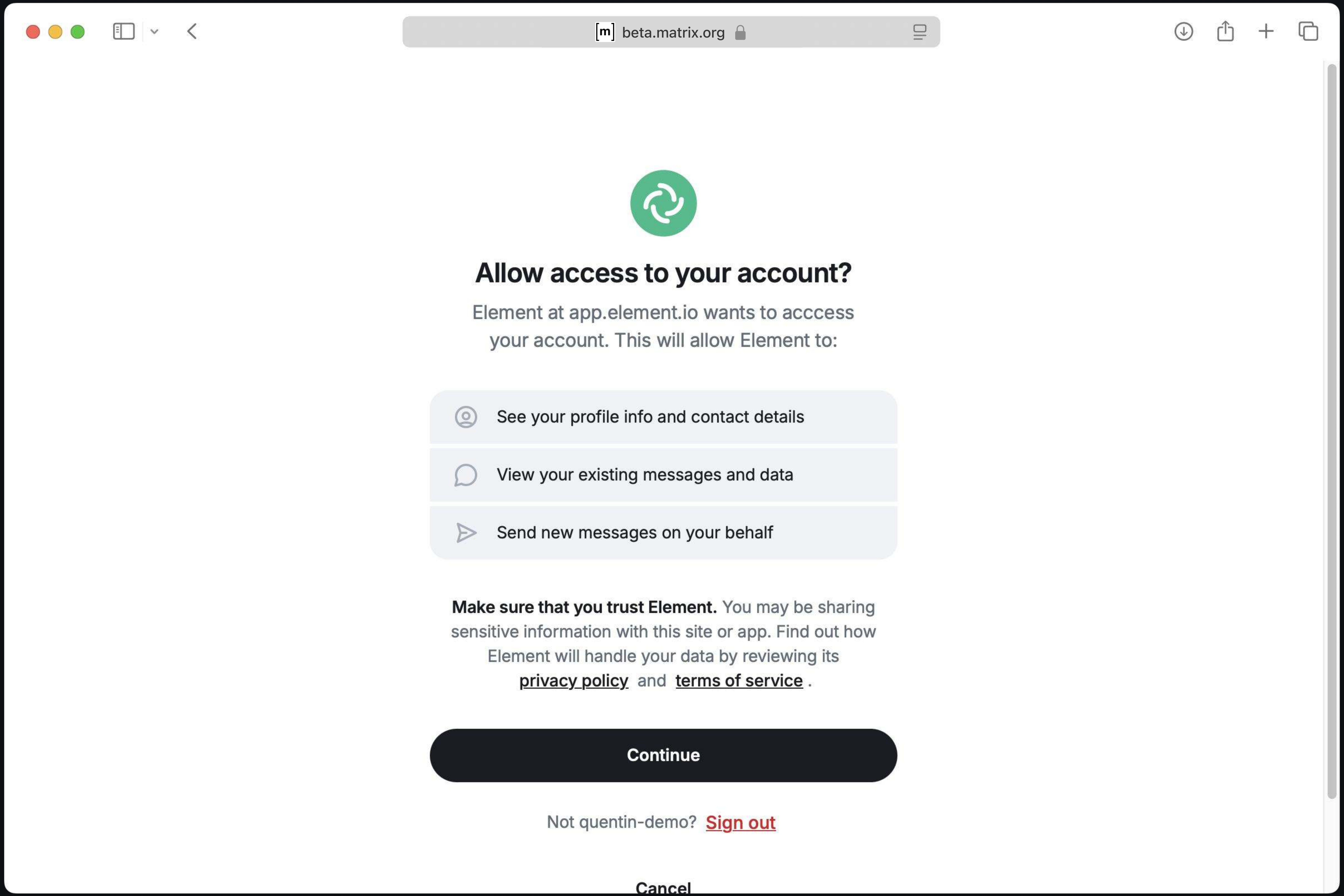


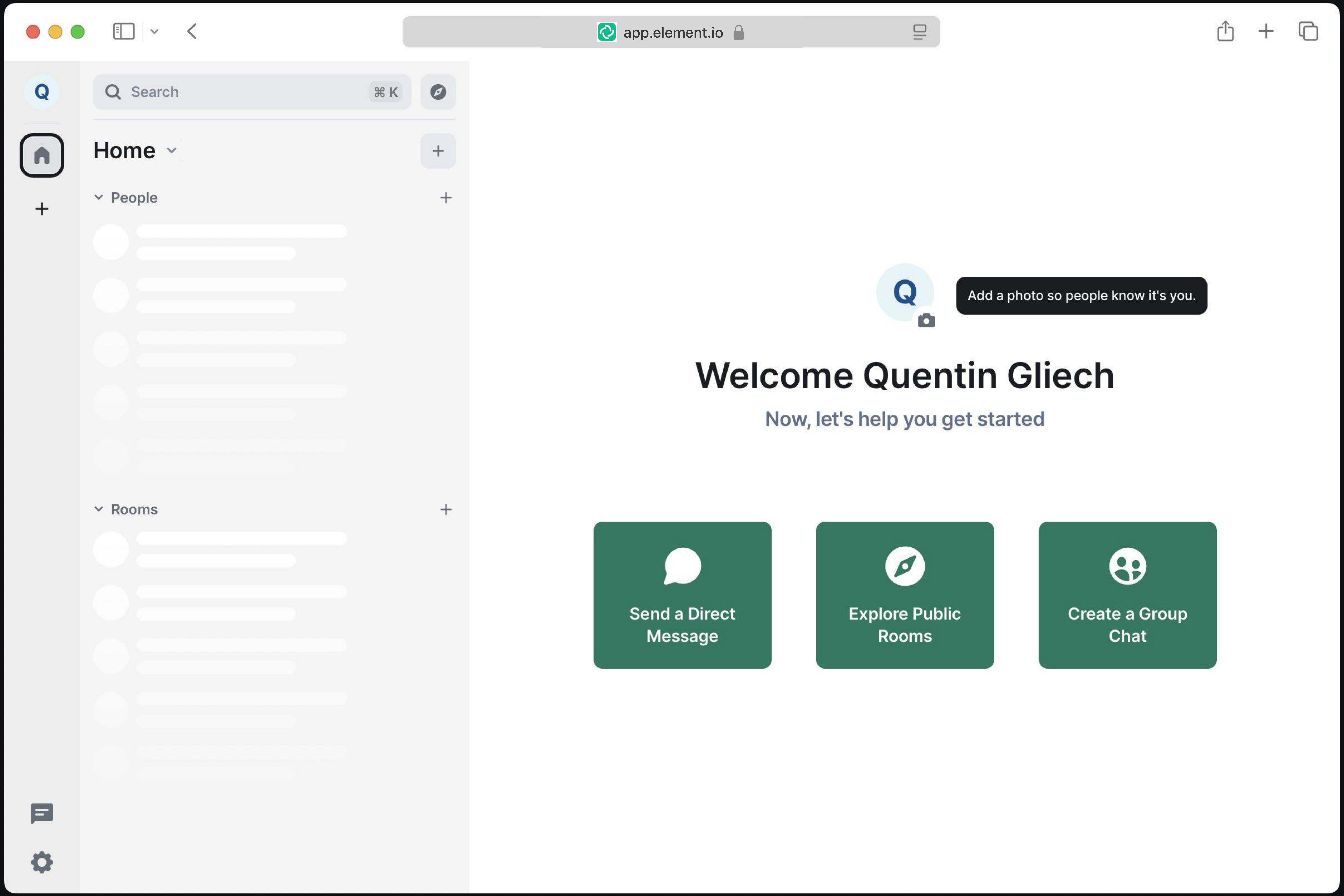
Allow access to your account?

Element at app.element.io wants to acccess your account. This will allow Element to:

- See your profile info and contact details
- View your existing messages and data
- Send new messages on your behalf

**Make sure that you trust Element.** You may be sharing sensitive information with this site or app. Find out how Element will handle your data by reviewing its privacy policy and terms of service .

Not quentin-demo? Sign out



Add a photo so people know it's you.

Welcome Quentin Gliech

Now, let's help you get started

## Issue #1:
## Auth steps are dynamic, should be specced and supported by clients

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# Auth steps are dynamic, should be specced and supported by clients

## Introducing new steps is hard

If we want a nice user experience, **client should natively support** all the steps presented. This makes it **harder to introduce new mechanisms**, and raises the bar for new client implementations

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## Fallback mechanism isn’t enough

**UIA has a fallback** mechanism for making new steps work, but they are **not well designed for mobile**, and don’t provide a coherent design for clients

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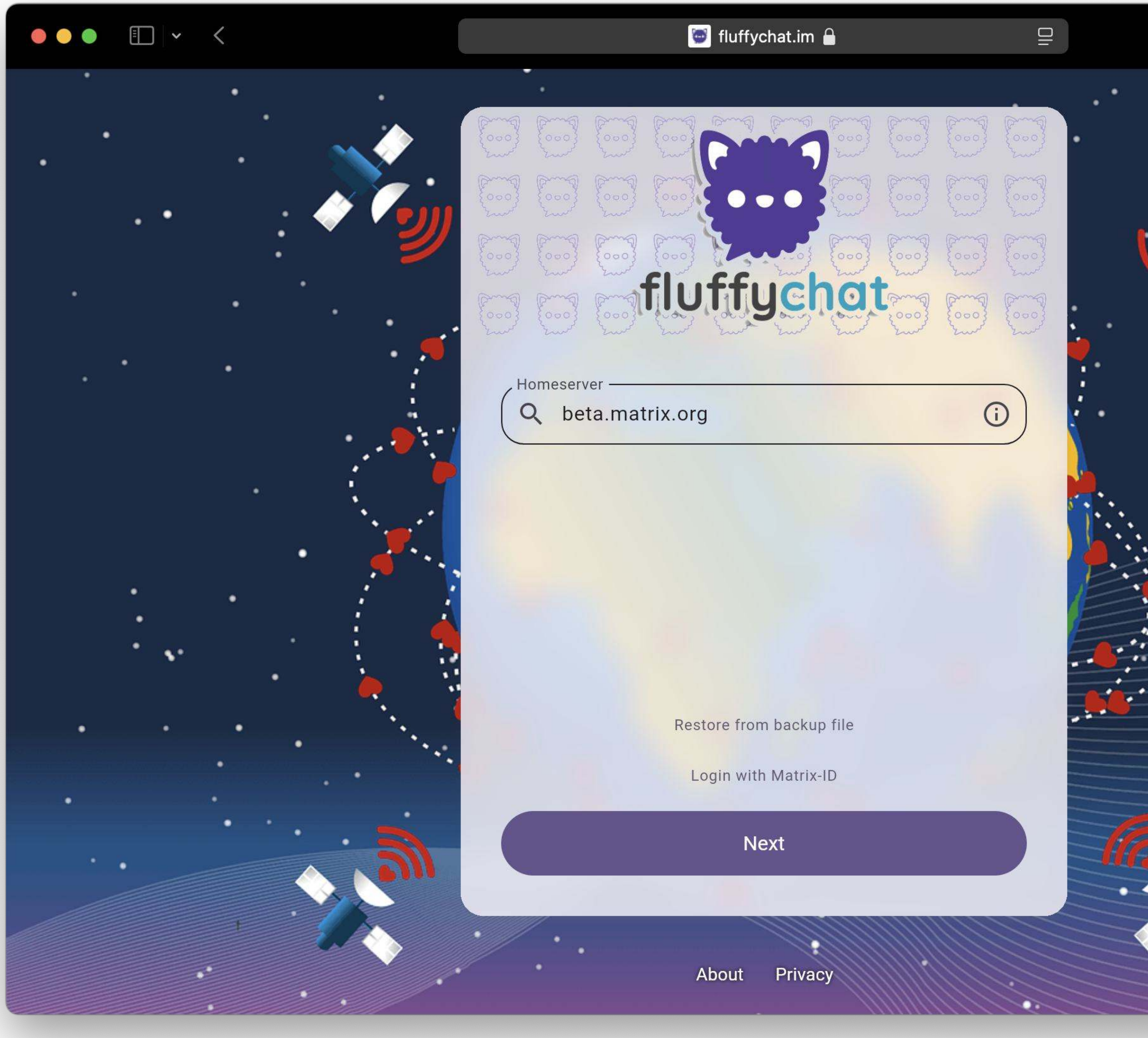
**UIA has a fallback** mechanism for making new steps work, but they are **not well designed for mobile**, and don't provide a coherent design for clients

## Dynamic user-interfaces are hard

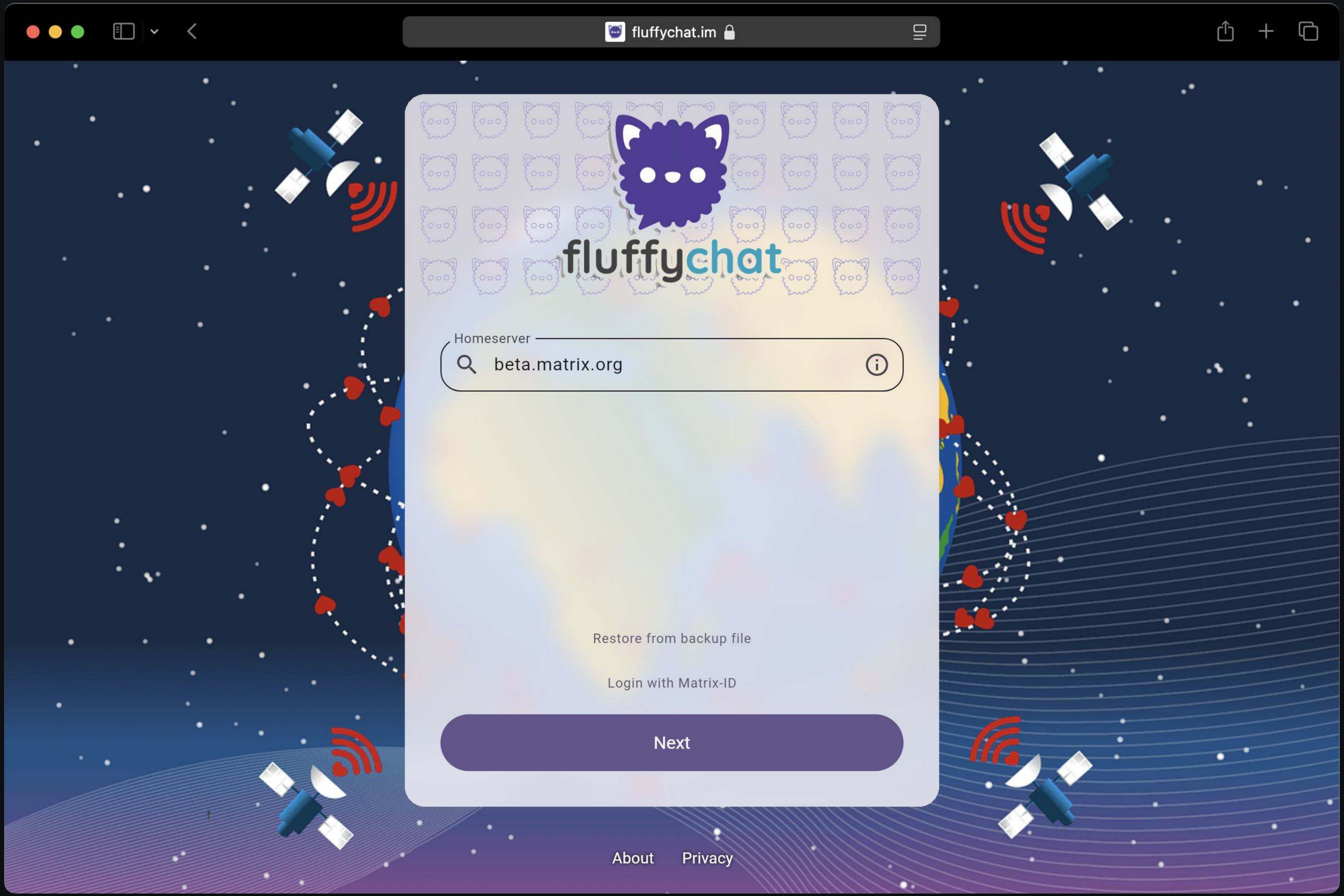
The **list of steps** presented in UIA is **dynamic**, which makes it hard for clients to build a coherent flow if they can't predict what combination is going to be asked by the server

# Let’s login in another client

I would like to try out FluffyChat
with my brand new Matrix account

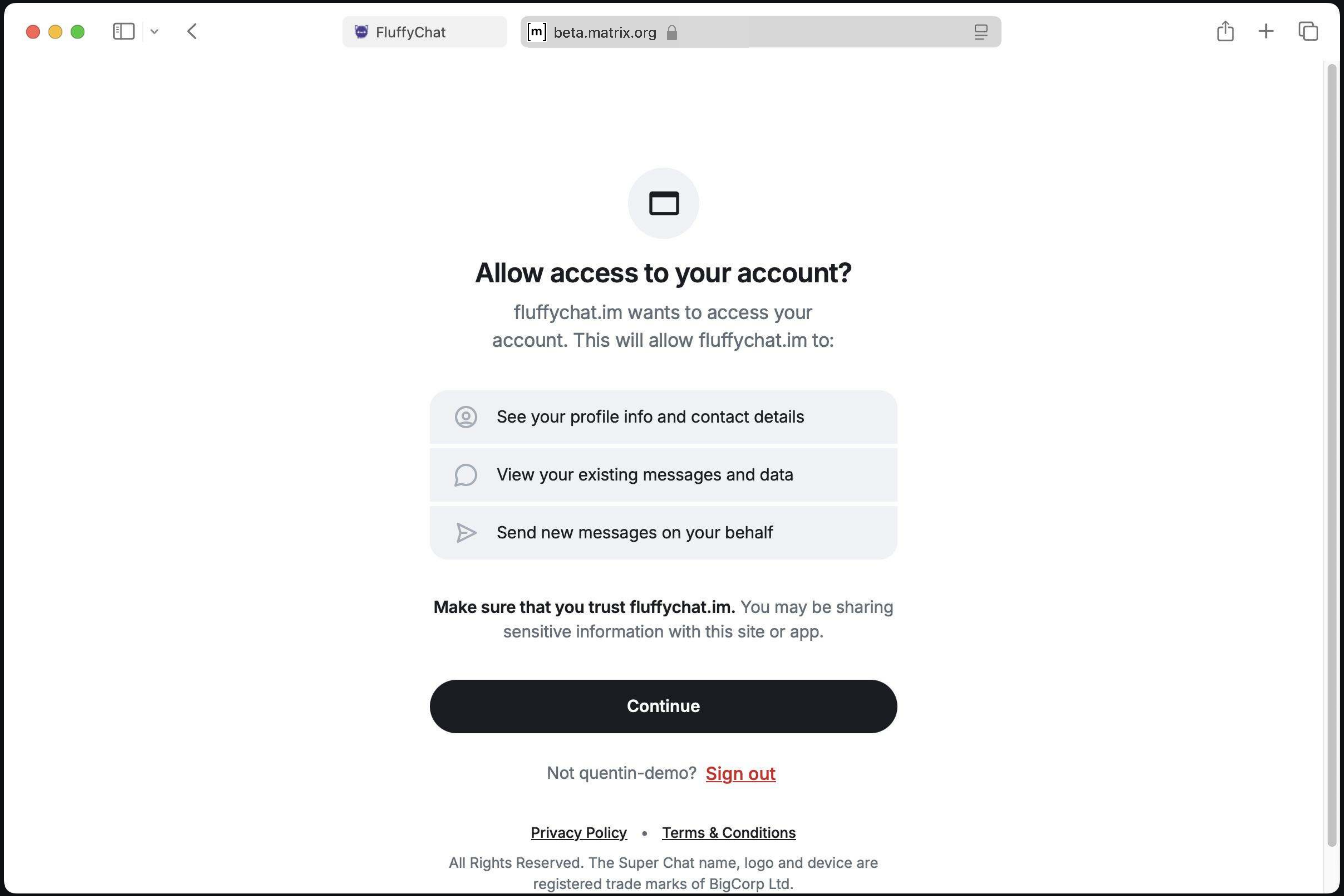


Homeserver: beta.matrix.org



Homeserver

beta.matrix.org



## Allow access to your account?

fluffychat.im wants to access your account. This will allow fluffychat.im to:

- See your profile info and contact details
- View your existing messages and data
- Send new messages on your behalf

**Make sure that you trust fluffychat.im.** You may be sharing sensitive information with this site or app.

Not quentin-demo? Sign out

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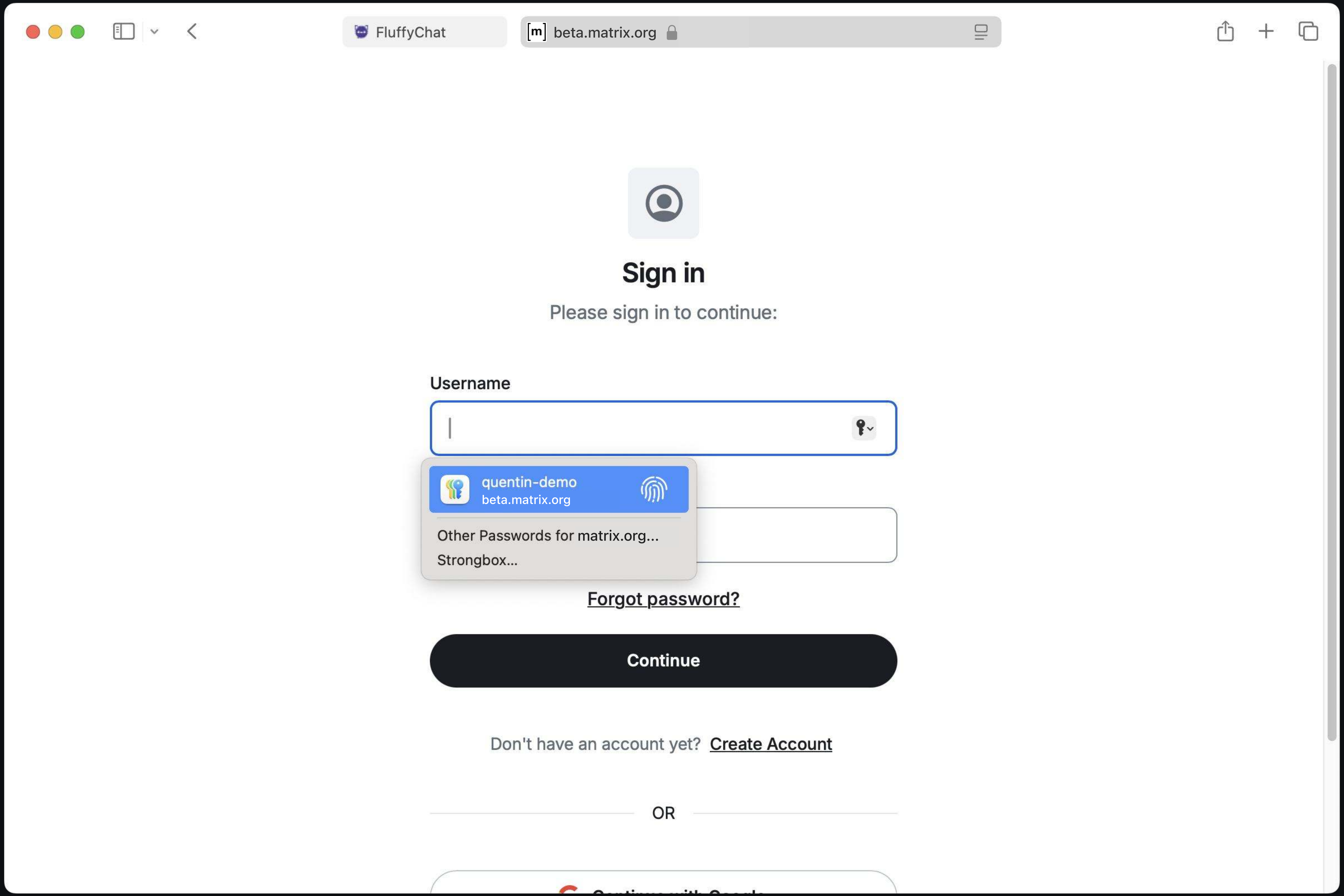
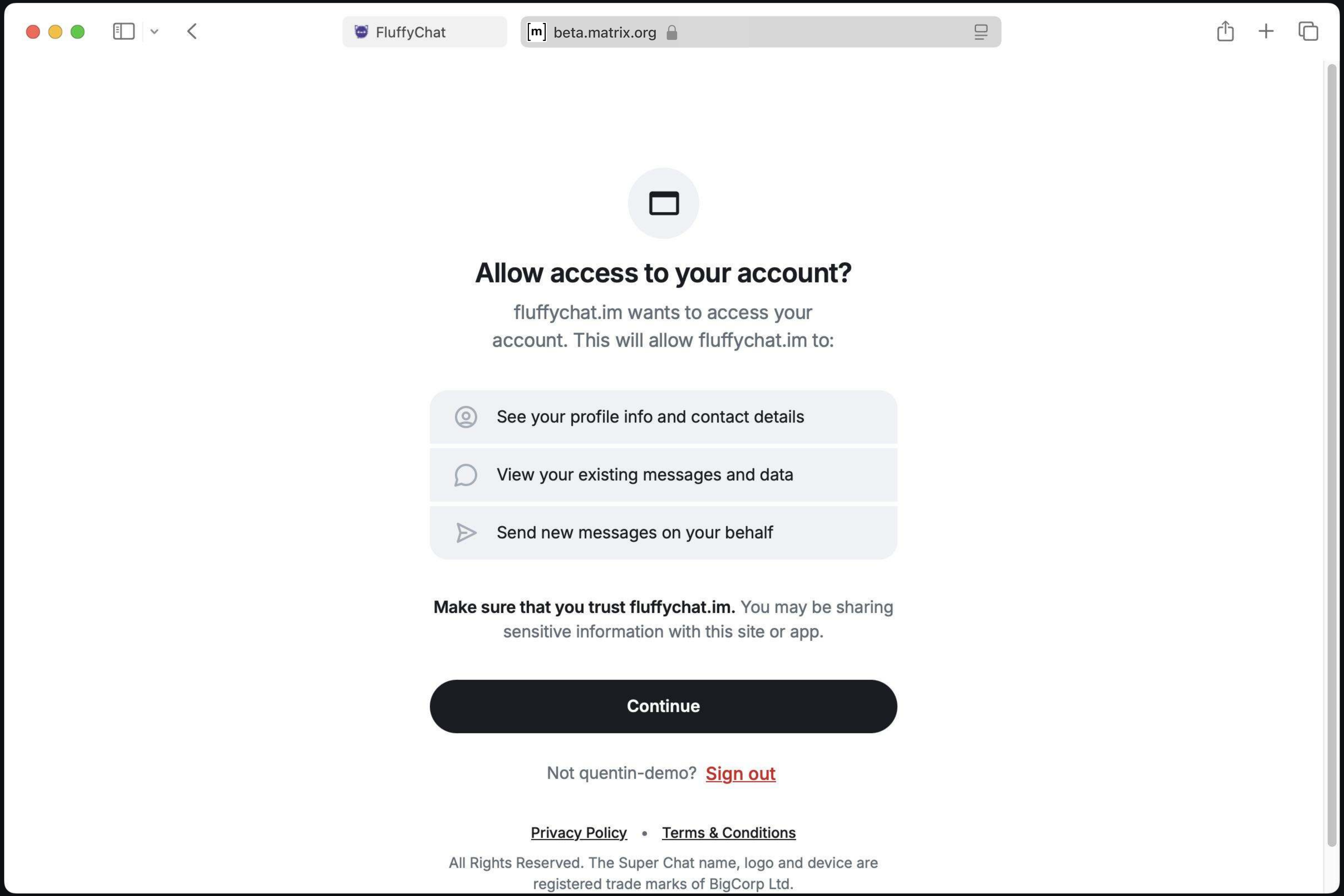


## Sign in

Please sign in to continue:

Username

Don't have an account yet? Create Account



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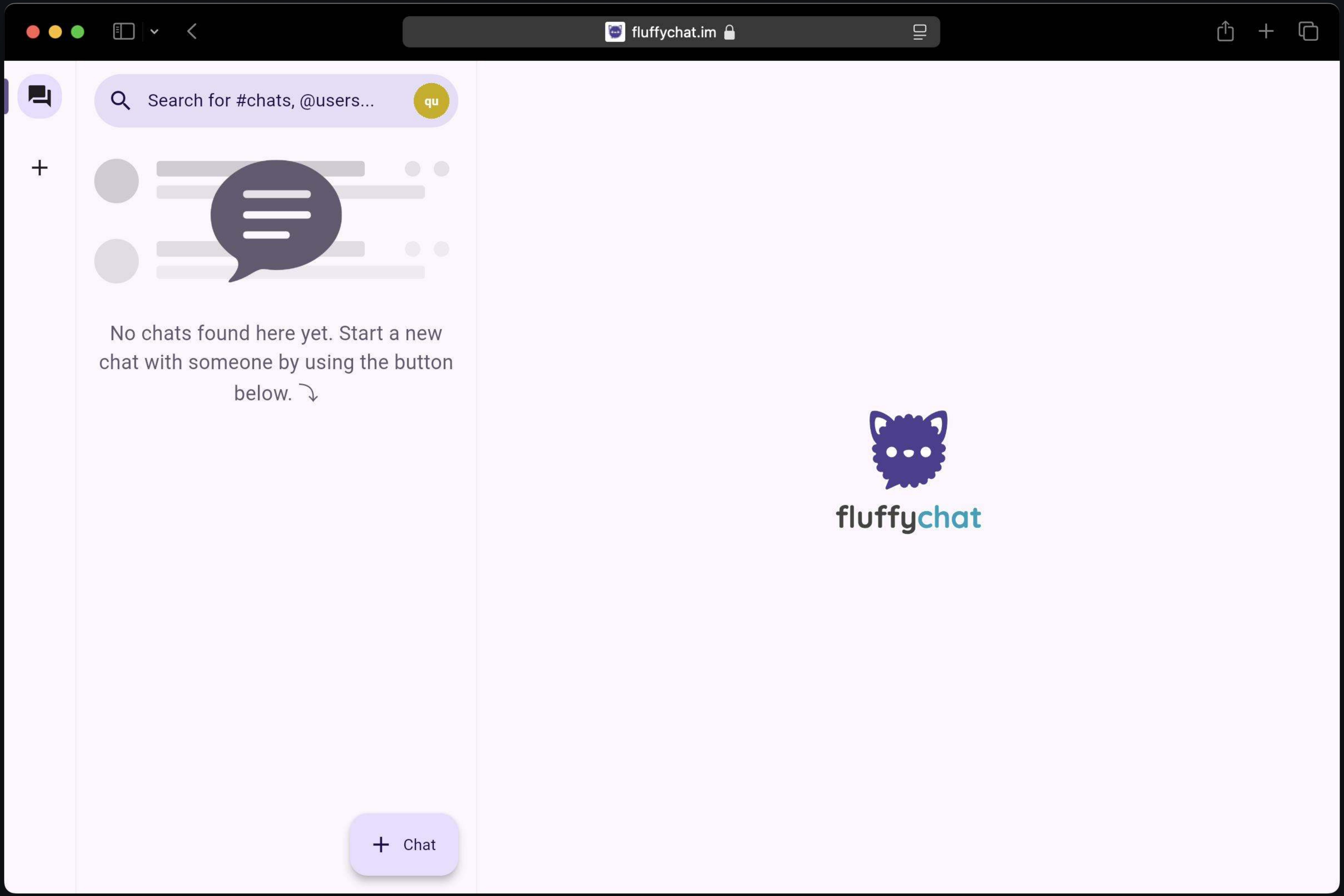
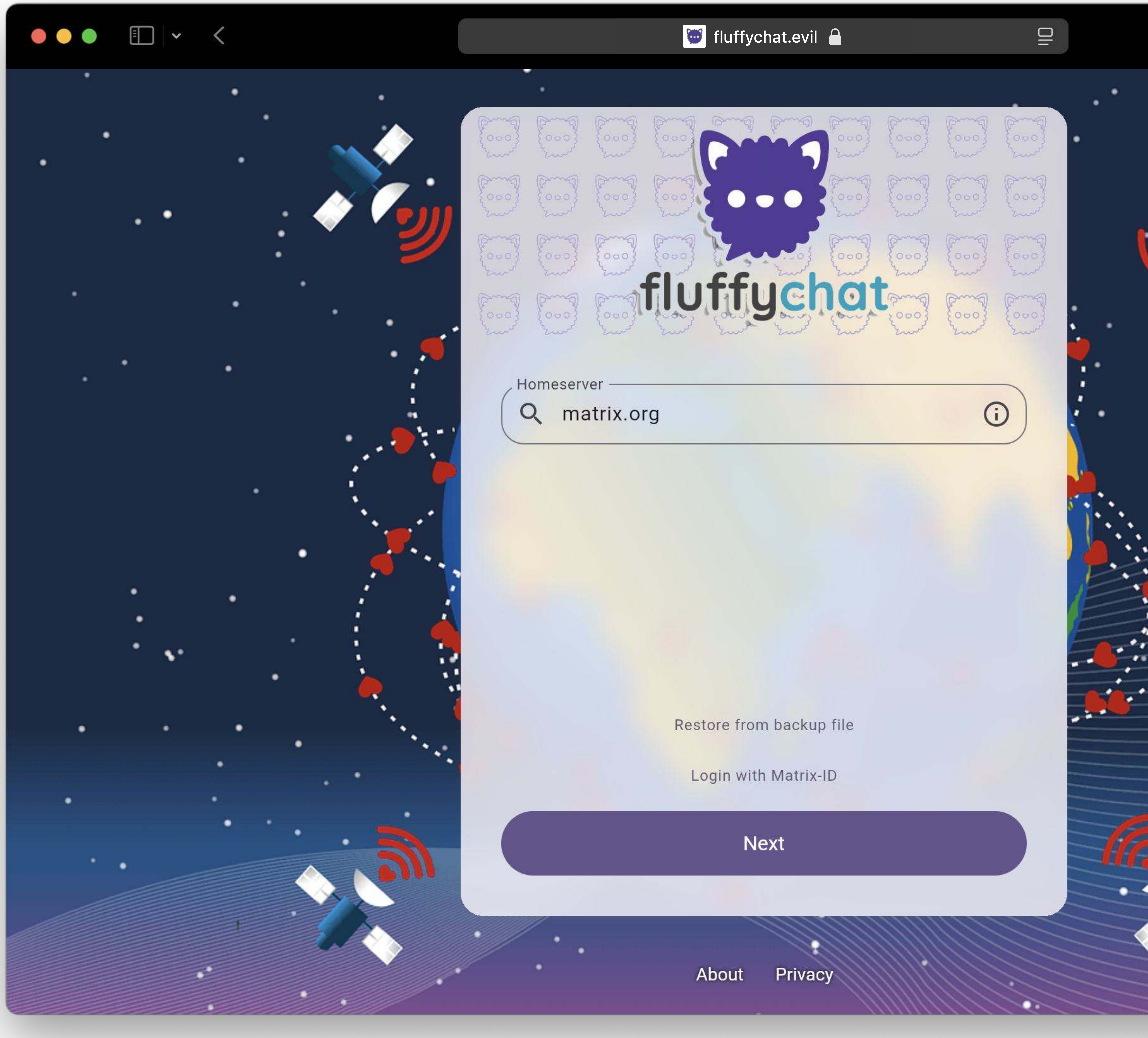


No chats found here yet. Start a new chat with someone by using the button below.

# And on Matrix.org?

How does a login look like on the current authentication stack?

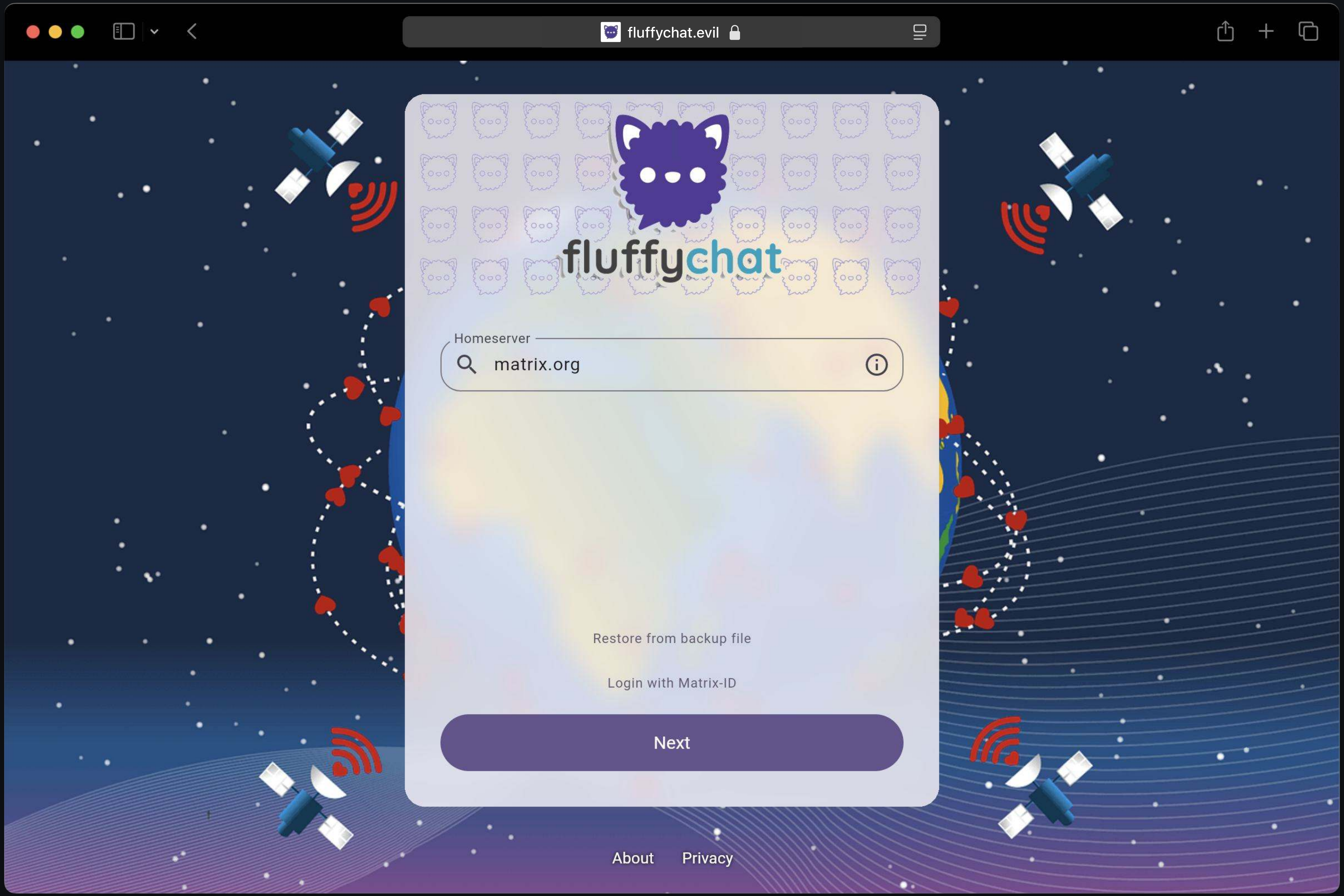


fluffychat.evil

fluffychat

Homeserver

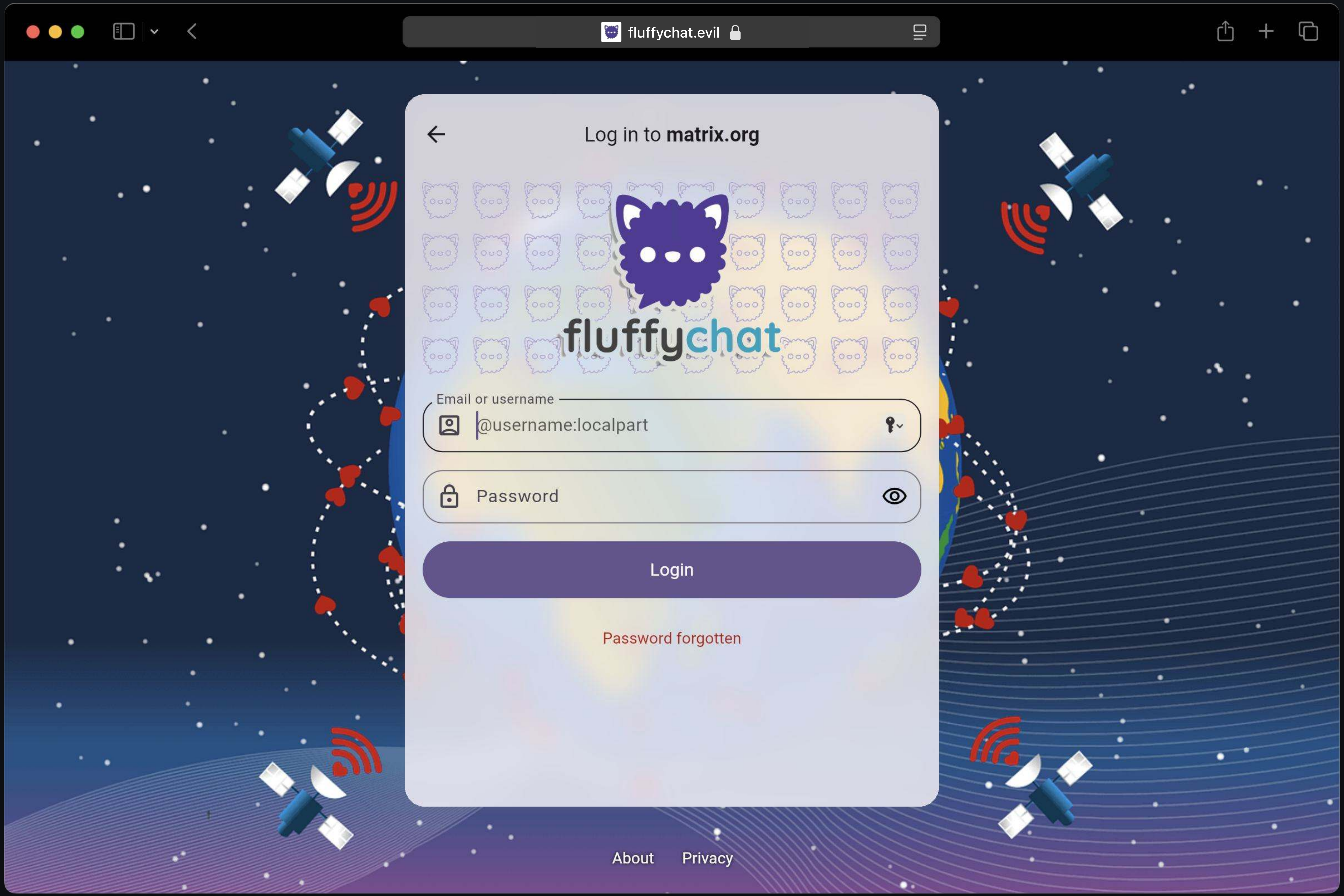
matrix.org



fluffychat.evil

Homeserver

matrix.org



fluffychat.evil

Log in to **matrix.org**

Email or username

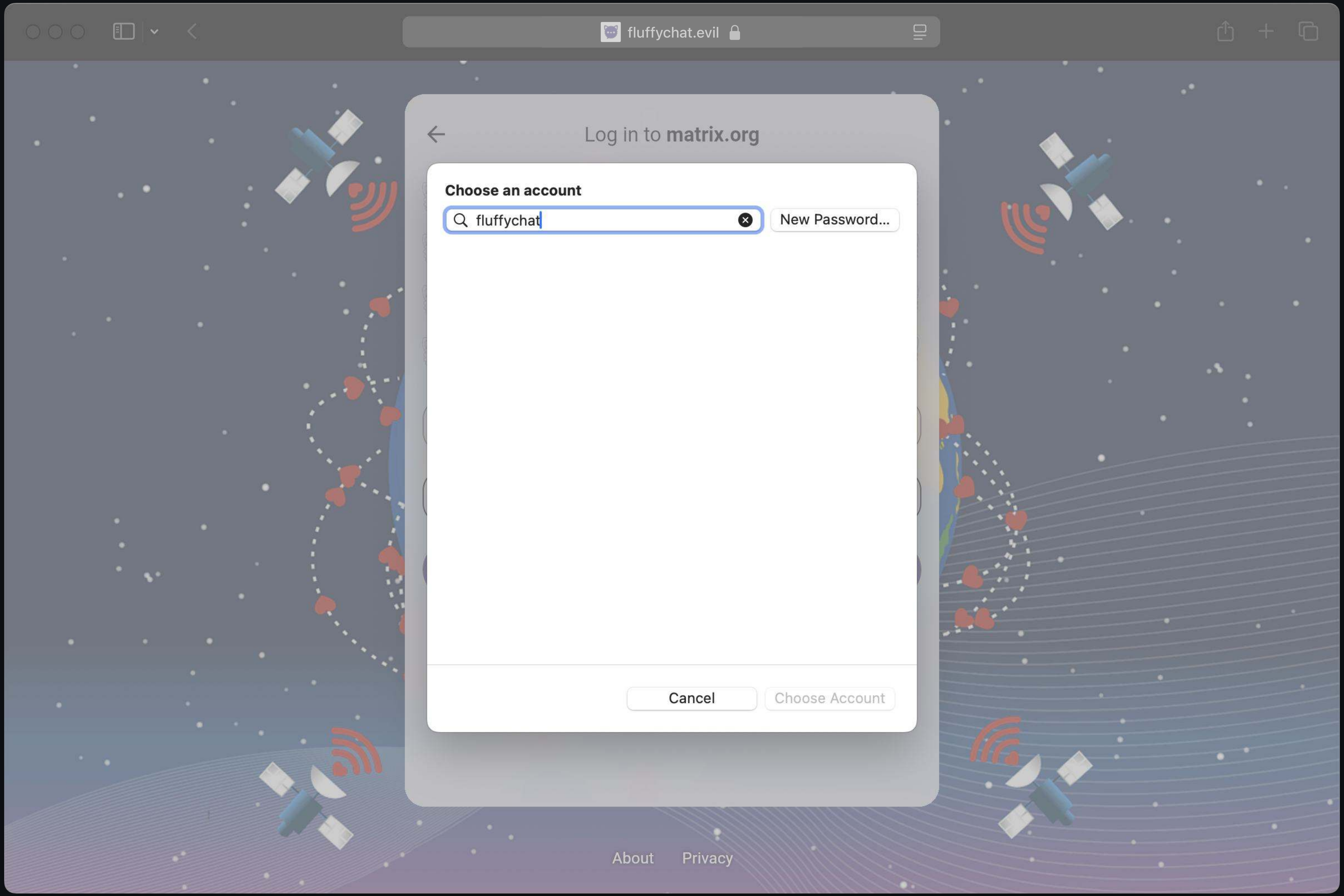
@username:localpart

Password

Login

Password forgotten

About Privacy

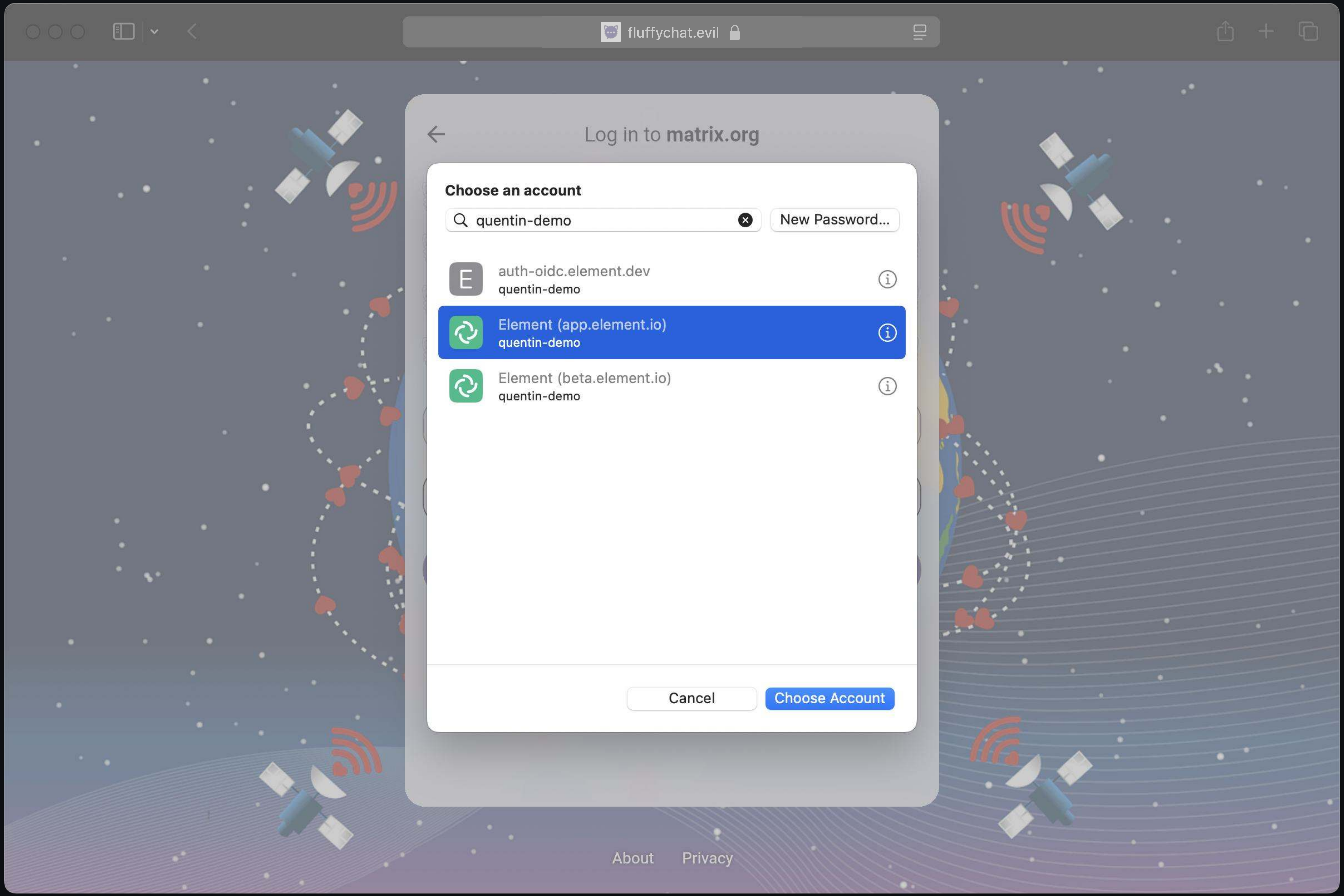

fluffychat.evil
Log in to **matrix.org**
Choose an account
fluffychat
New Password...
Cancel
Choose Account
About
Privacy

# Issue #2: Credentials are bound to the domain

Your credentials are supposed to be bound to the **service** and **not the client**

Password managers don’t behave well

CAPTCHAs, Passkeys, client certificates are all **bound to the domain**



fluffychat.evil

Log in to **matrix.org**

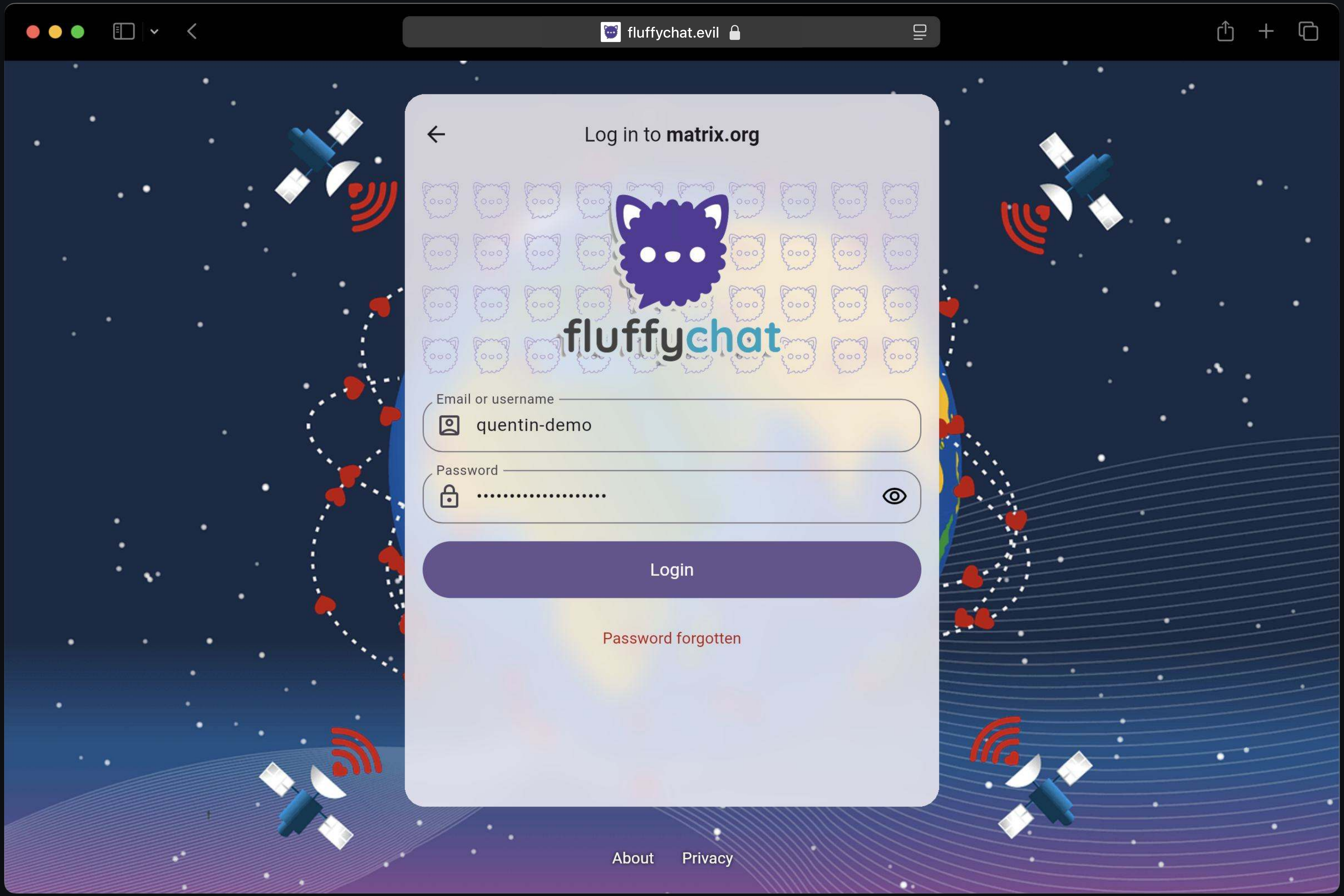
**Choose an account**

quentin-demo

auth-oidc.element.dev
quentin-demo

Element (app.element.io)
quentin-demo

Element (beta.element.io)
quentin-demo



fluffychat.evil

Log in to **matrix.org**

Email or username: quentin-demo

Password: ••••••••••••••••••••

Login

Password forgotten

About Privacy

fluffychat.evil

Log in to **matrix.org**

fluffychat

# Issue #3:
# Clients have access to the full credentials

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## Are destructive actions really protected?

**Deactivating** the account, changing **email addresses**, changing **password** are supposed to be protected by UIA.
On matrix.org, that means **re-submitting the password**

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Users are currently handing out their credentials to many parties, effectively **widening the attack surface**

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Users are currently handing out their credentials to many parties, effectively **widening the attack surface**

## Can’t restrict access to the client

If the client has full access over the credentials, we can’t design anything that gives restricted access to a client.
**We cannot give partial access to the account**, to a subset of rooms, to a specific room type, etc.

## Issue #1:
## Auth steps are dynamic

## Issue #2:
## Credentials are bound to the domain

## Issue #3:
## Clients have access to the full credentials

Issue #1:
Auth steps
are dynamic

Issue #2:
Credentials are
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Issue #3:
Clients have access
to the full credentials

## Auth through the browser fixes this

## Issue #1: Auth steps are dynamic

The server can present any kind of browser-based UI, in a streamlined and coherent way

## Issue #2: Credentials are bound to the domain

Credentials are bound to the **domain of the service** instead of the domain of the client

## Issue #3: Clients have access to the full credentials

Clients don’t see the full credentials. The user enters them in a UI controlled by the service

# Matrix already has m.login.sso

1. The client redirects to the homeserver to start the authentication
2. The homeserver authenticates the user
3. It redirects back to the client with a single-use code
4. The client exchanges that code to get an access token

**This mechanism is simple yet powerful**

Me : mom can we have **Secure auth through the browser** ?

Mom : no, we have **Secure auth through the browser** at home

at home : `m.login.sso`

# m.login.sso is a ~~bad~~ limited version of the OAuth 2.0 authorisation code grant

## OAuth 2.0

The industry-standard authorisation **framework**, developed within the **IETF** OAuth Working Group

## OpenID Connect

An identity layer **on top of OAuth 2.0**, helping with better interoperability, developed by the **OpenID Foundation**

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### They are building blocks

We need to define a *profile* on top of them:

- what homeservers and clients **must** support to be compliant
- how we model Matrix concepts with them

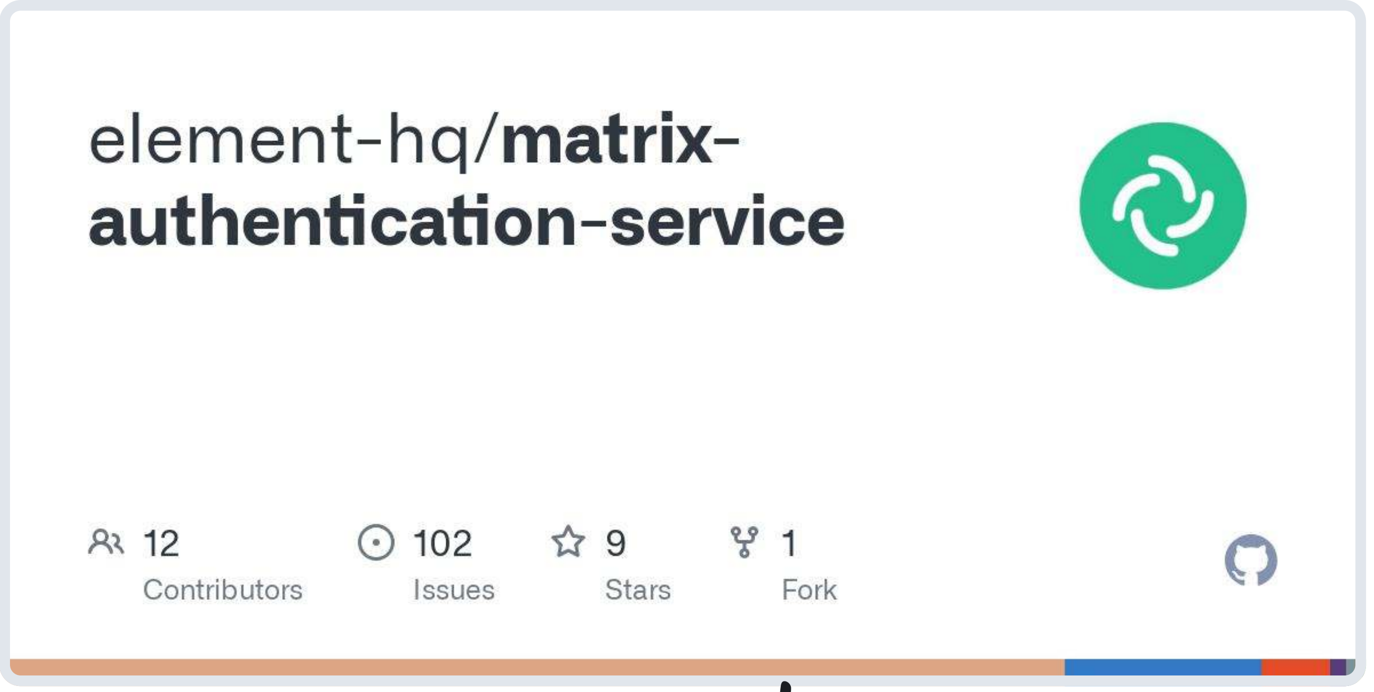
### Cover many use cases

- browser-based flow with the **authorisation code grant**
- authorise on another device with the **device code grant**
- “service account” use cases with the **client credentials grant**

# Introducing matrix-authentication-service

Or: how 2940 commits and 80k lines of code later, we fixed auth.

# Introducing matrix-authentication-service



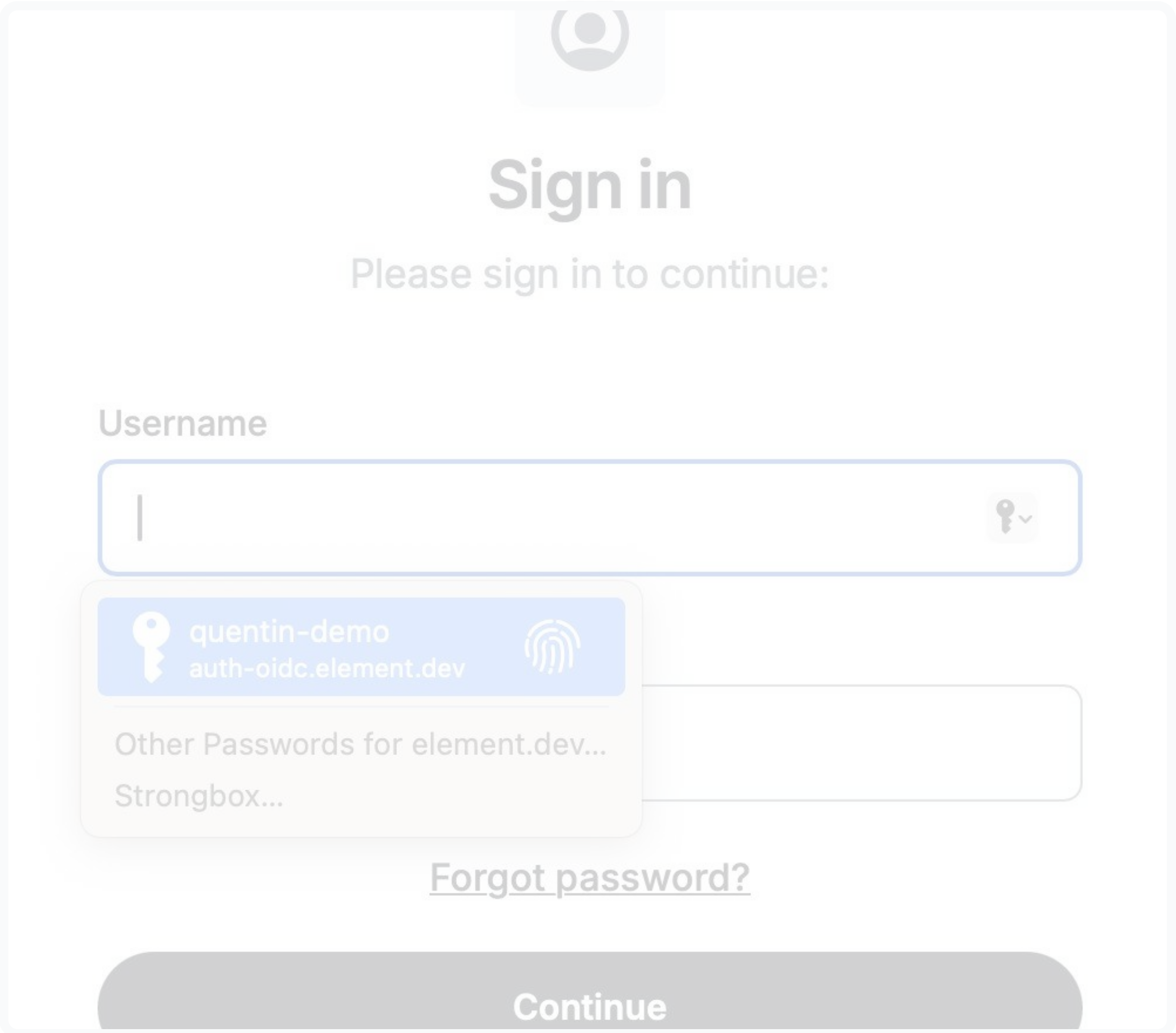
element-hq/**matrix-authentication-service**

12 Contributors · 102 Issues · 9 Stars · 1 Fork

Rust!

## Rewrite from the ground-up

**Complete rewrite** of Synapse's auth logic
Focused on a **good auth UX**
Could be **used by other** homeservers



Sign in

Please sign in to continue:

Username

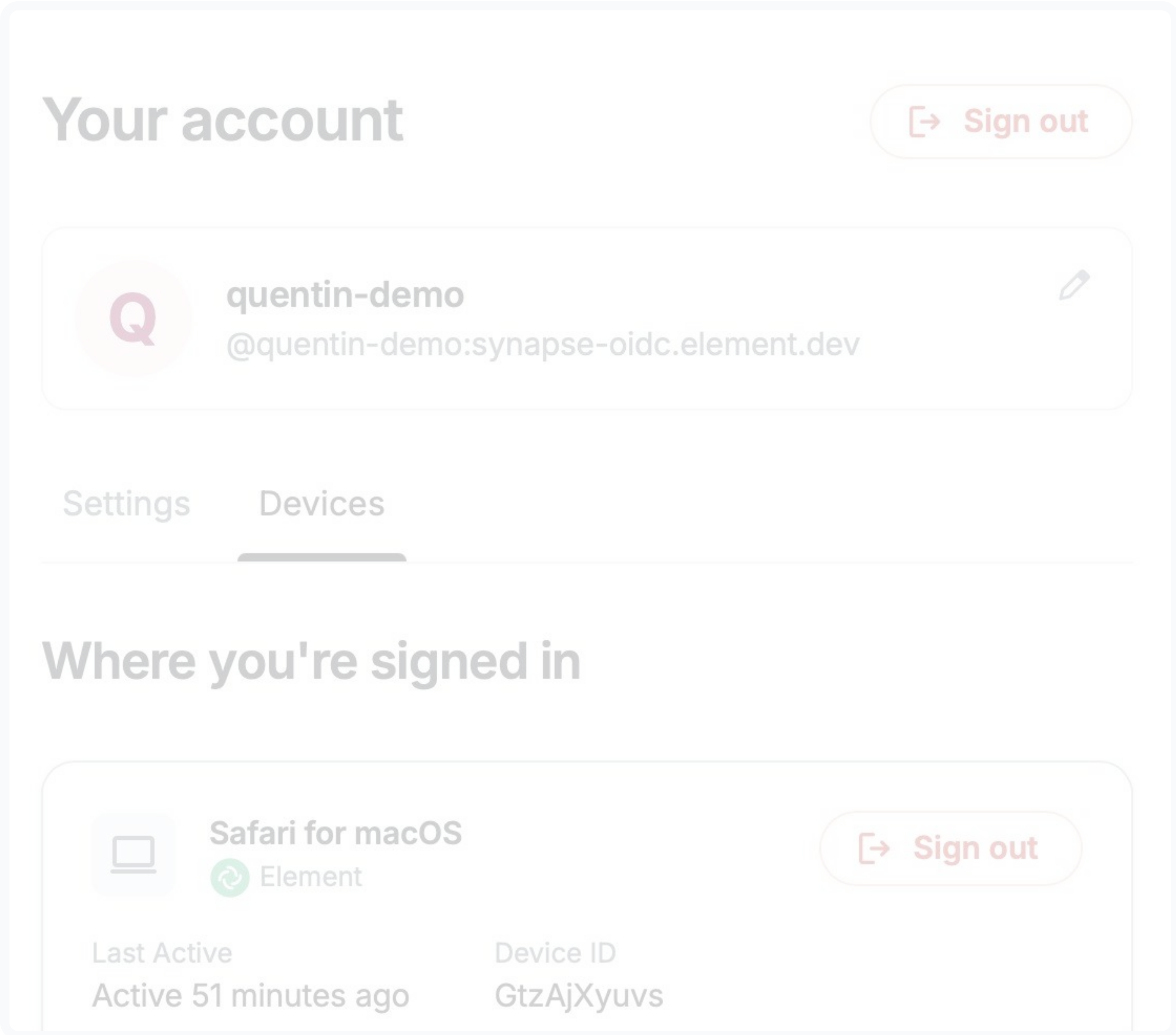
quentin-demo
auth-oidc.element.dev

Other Passwords for element.dev...
Strongbox...

Forgot password?

## Main flow is browser-based

Even for local-password authentication, making **password managers 'just work'**
Registration flow is ✨ delightful ✨



Your account

quentin-demo
@quentin-demo:synapse-oidc.element.dev

Where you're signed in

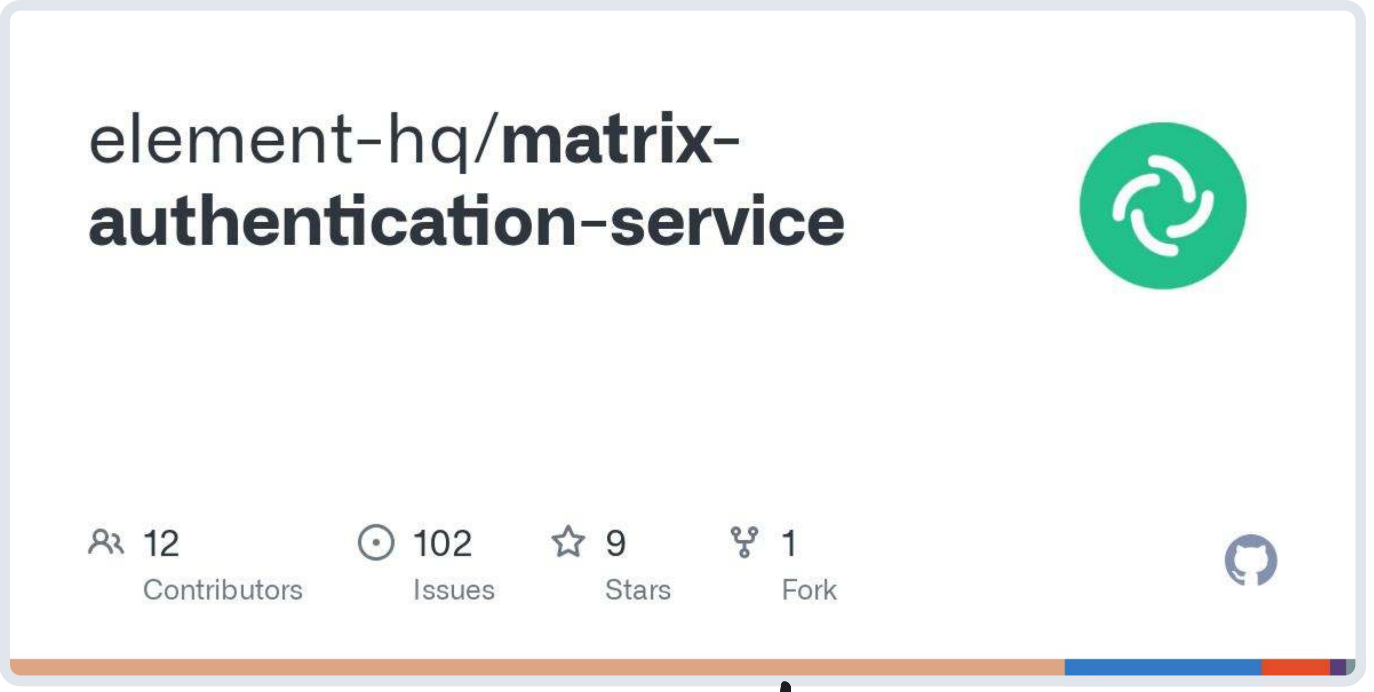
Safari for macOS
Element

Last Active: Active 51 minutes ago
Device ID: GtzAjXyuvs

## Account management UI

Dedicated **UI for managing your sessions**, password, email addresses, etc.

# Introducing matrix-authentication-service



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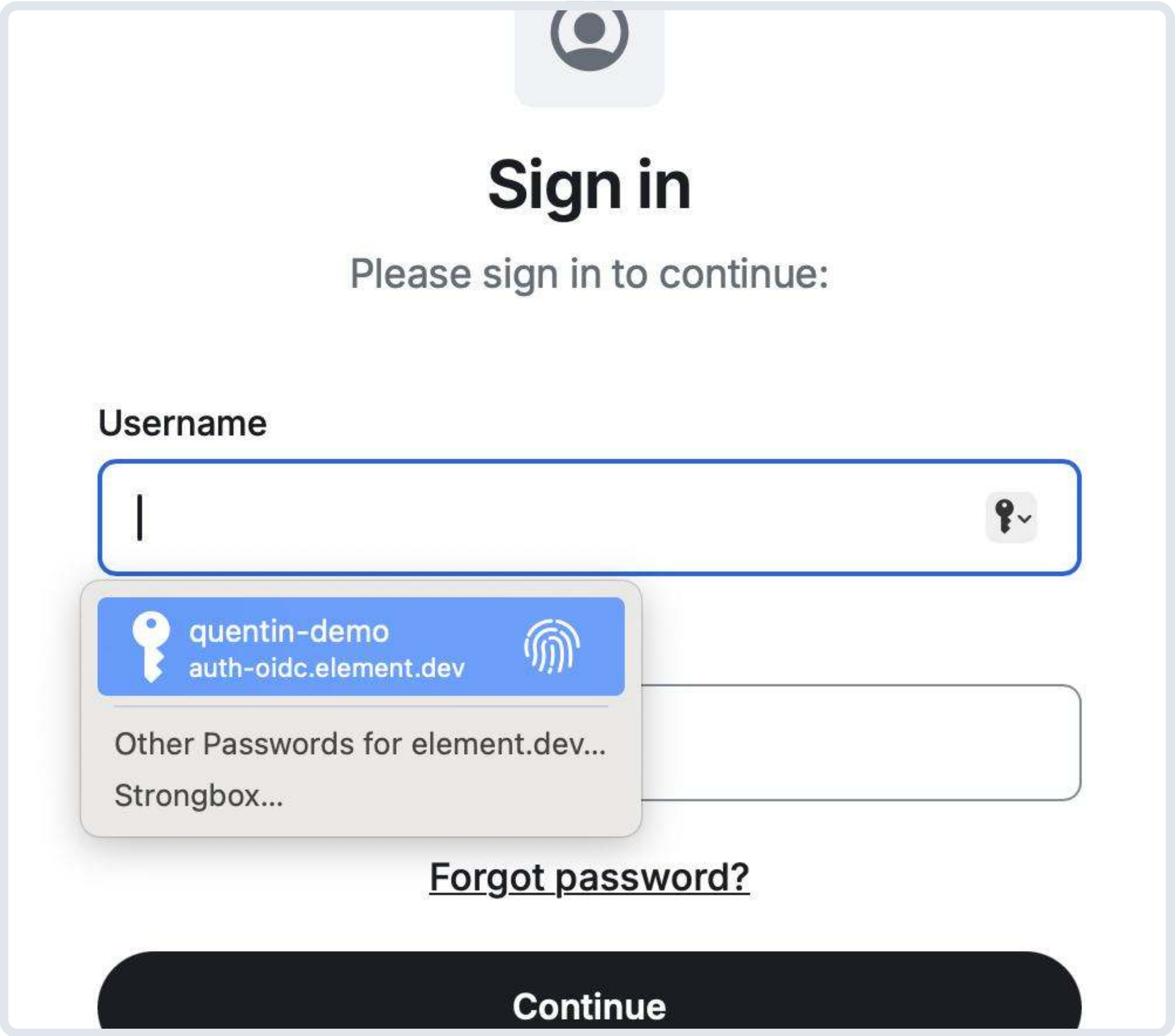

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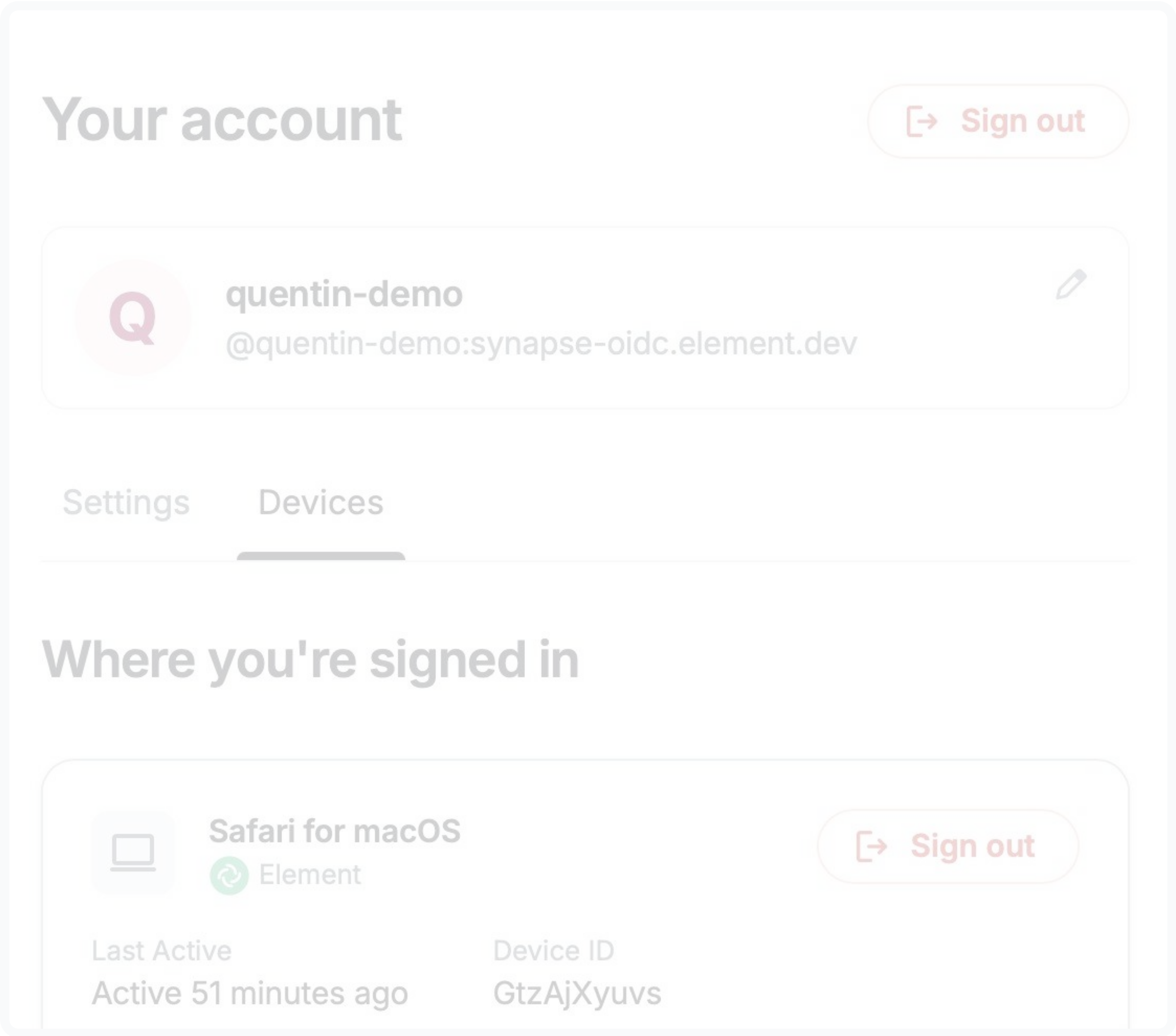

Your account

Sign out

Q
quentin-demo
@quentin-demo:synapse-oidc.element.dev

Settings
Devices

Where you're signed in

Safari for macOS
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Sign out

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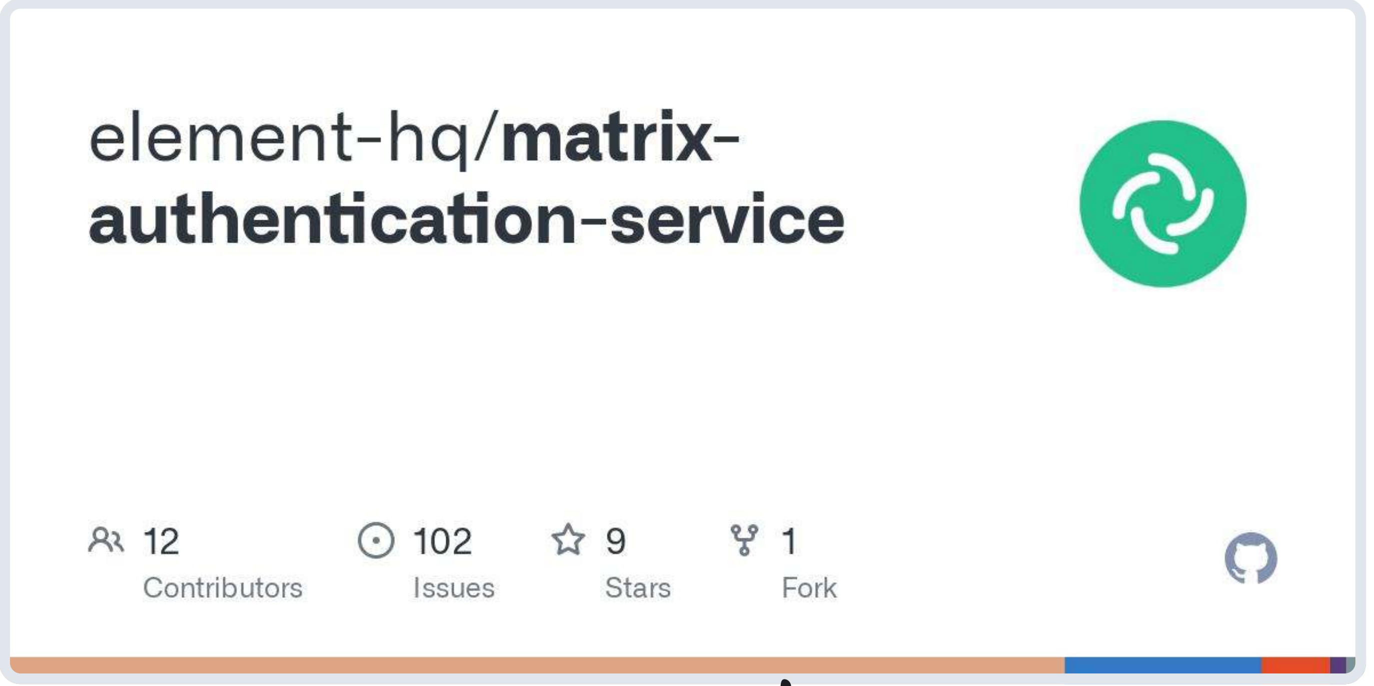

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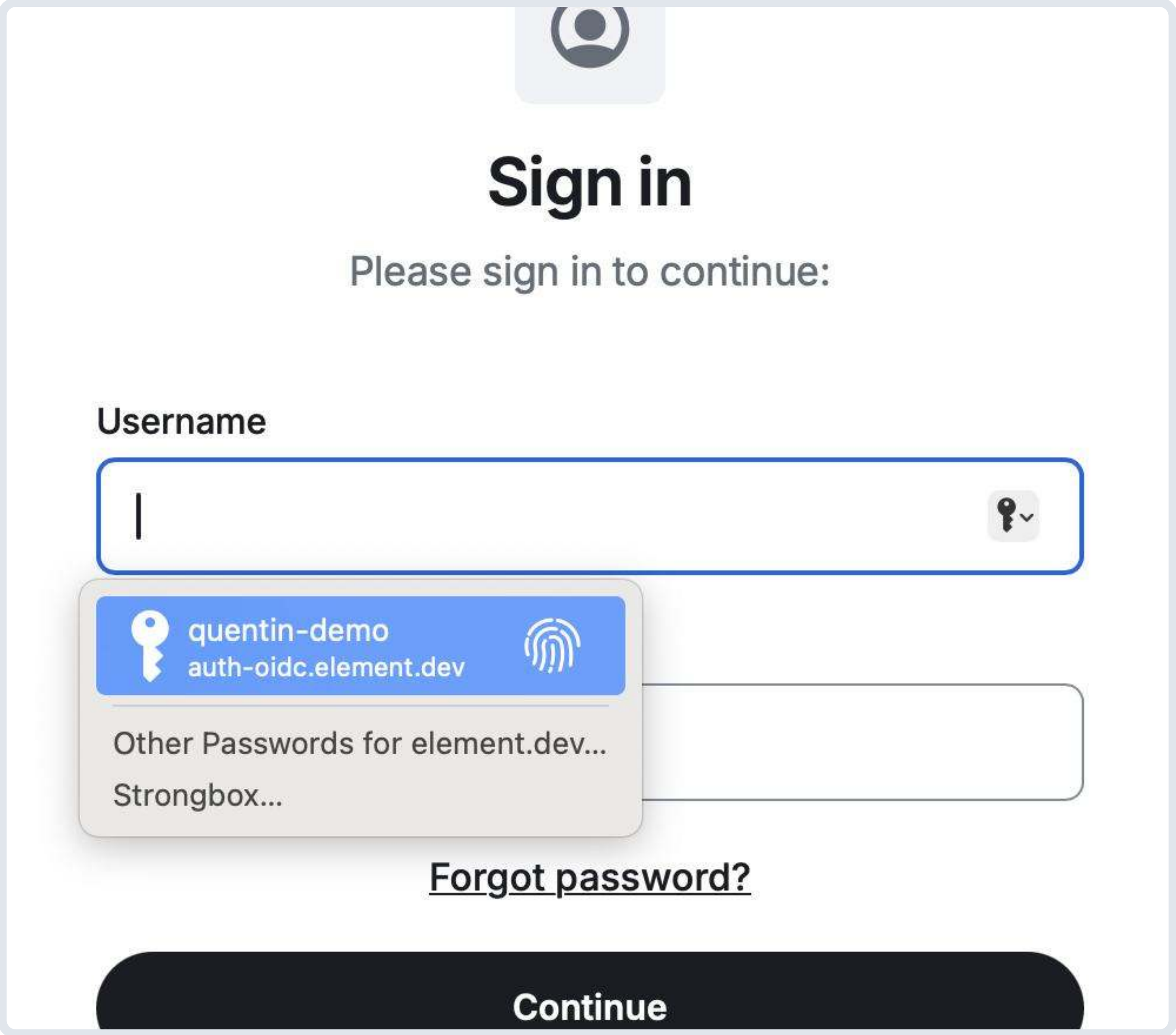

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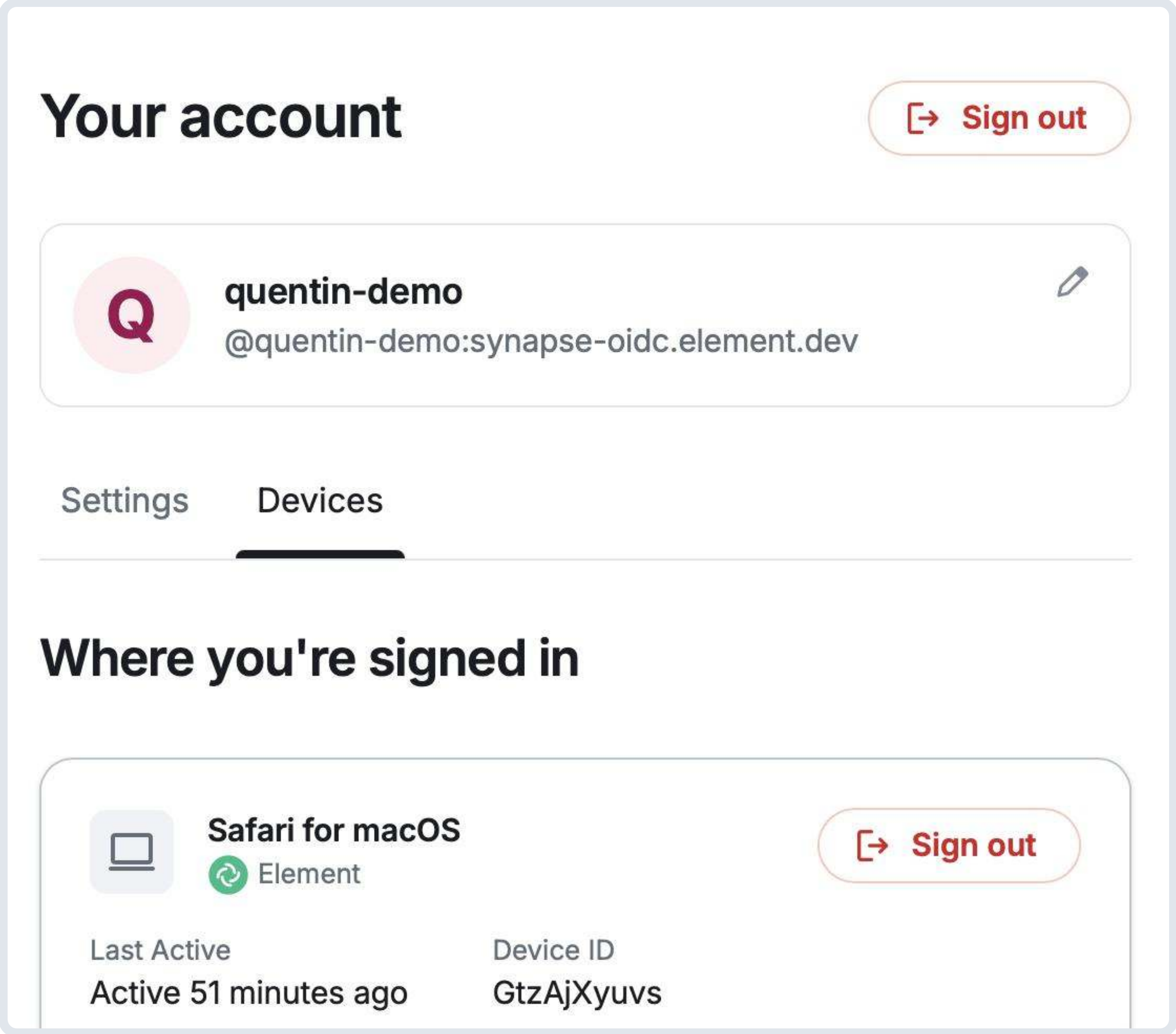

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Settings | Devices

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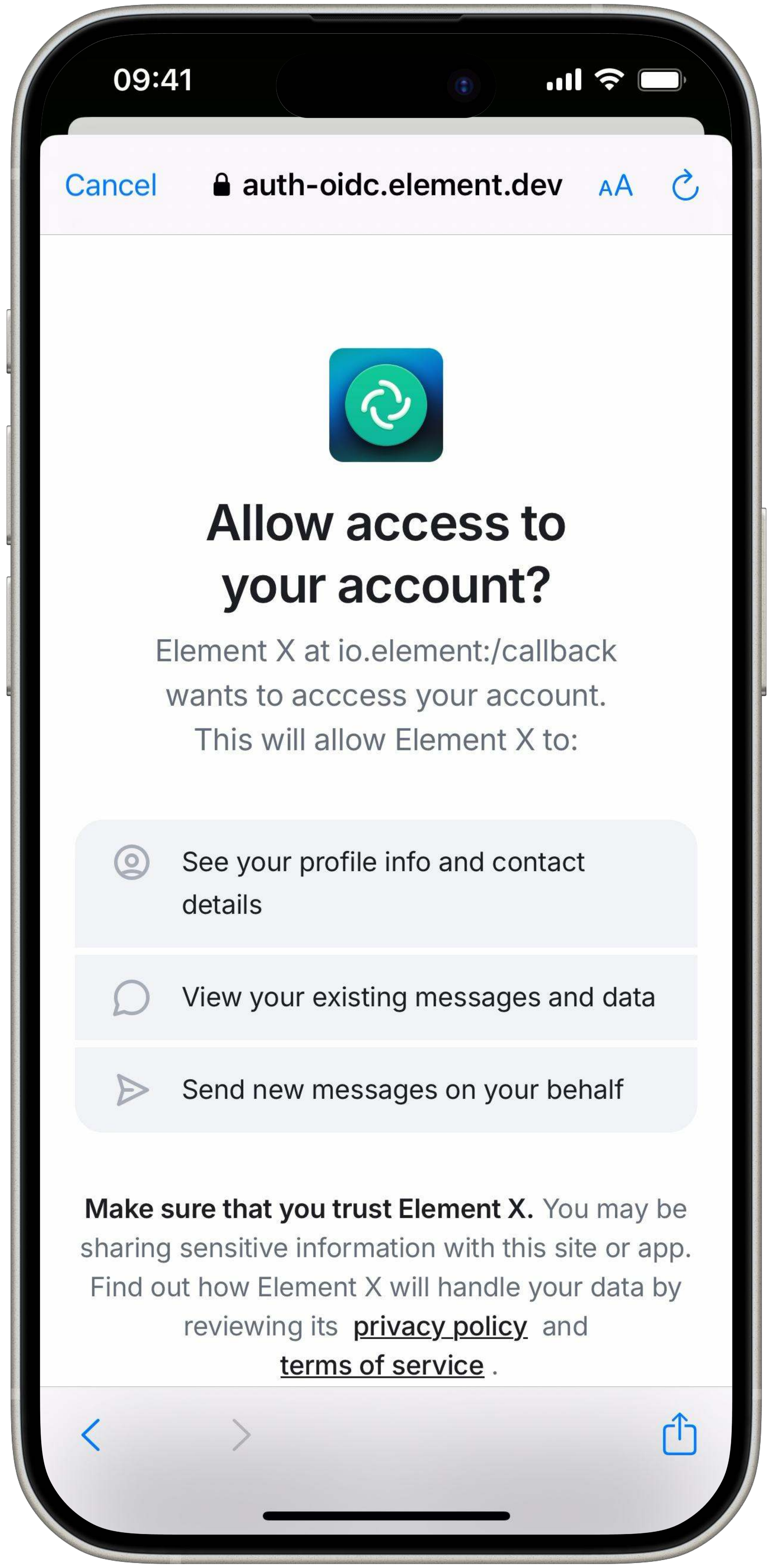
## Account management UI

Dedicated **UI for managing your sessions**, password, email addresses, etc.

# Works with most clients out of the box

Supports both **m.login.sso**
and the new **OAuth 2.0-based** flows

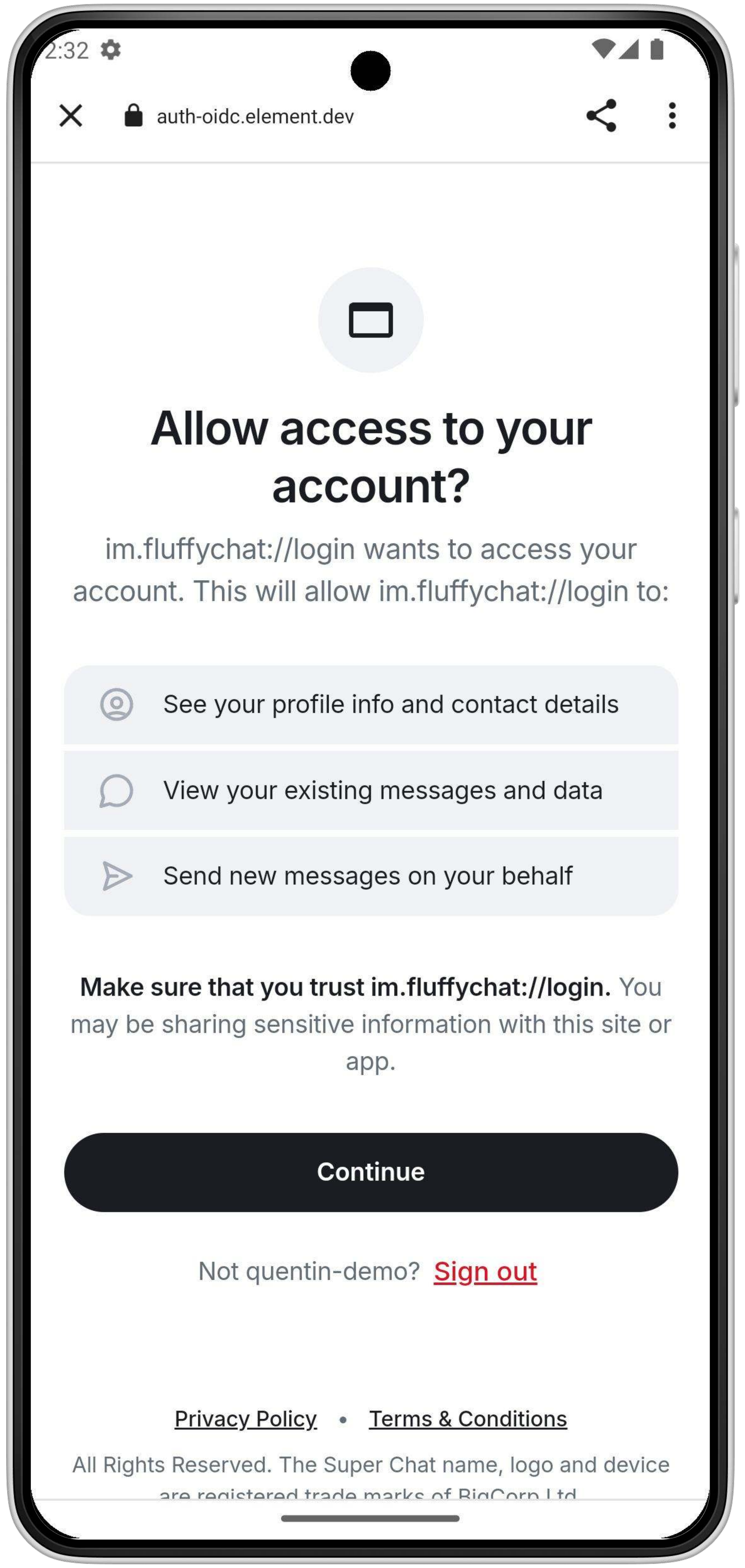


## Allow access to your account?

Element X at io.element:/callback wants to acccess your account. This will allow Element X to:

- See your profile info and contact details
- View your existing messages and data
- Send new messages on your behalf

**Make sure that you trust Element X.** You may be sharing sensitive information with this site or app. Find out how Element X will handle your data by reviewing its privacy policy and terms of service .



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im.fluffychat://login wants to access your account. This will allow im.fluffychat://login to:

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Continue

Not quentin-demo? Sign out

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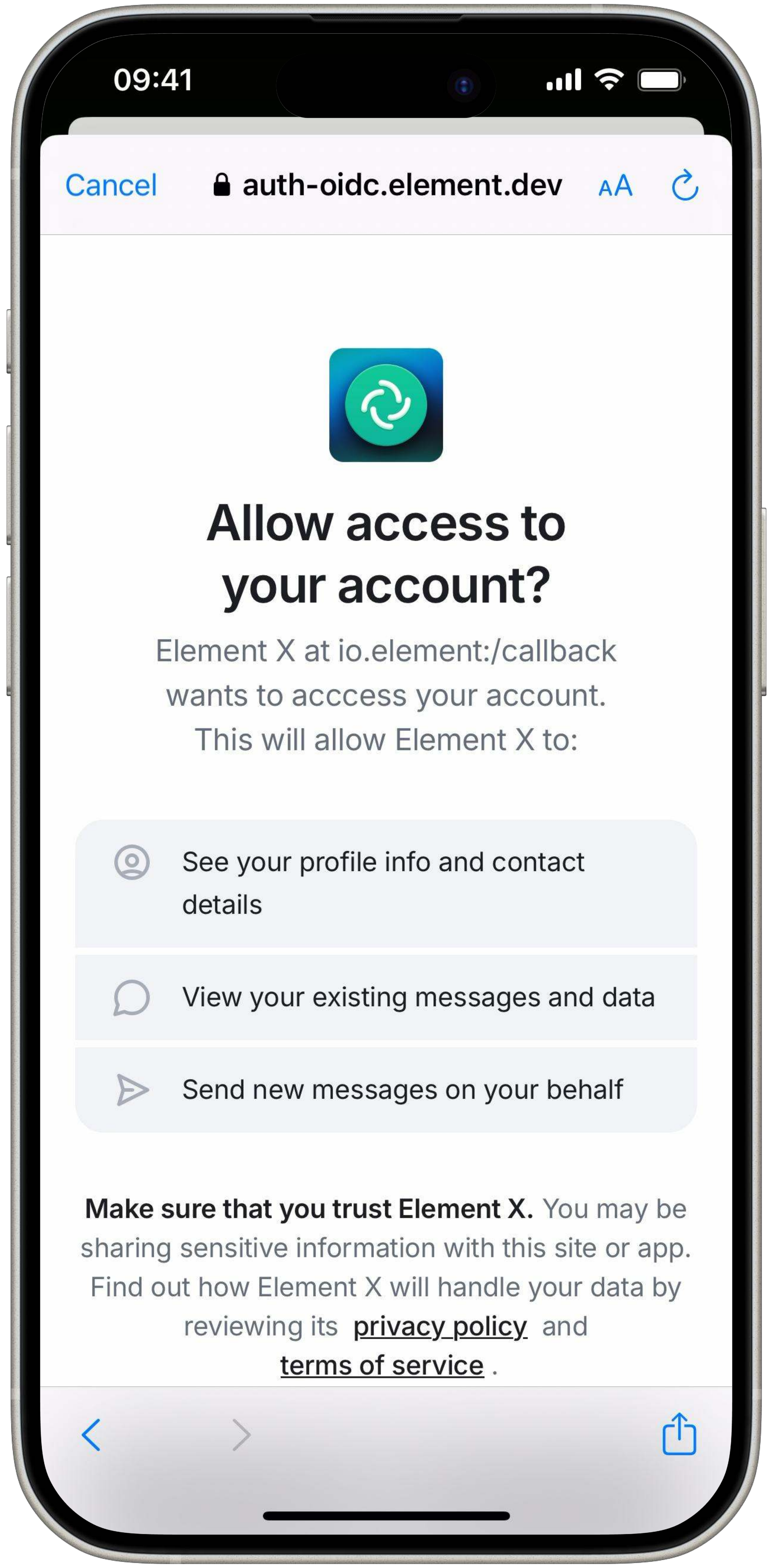

09:41

Cancel auth-oidc.element.dev AA

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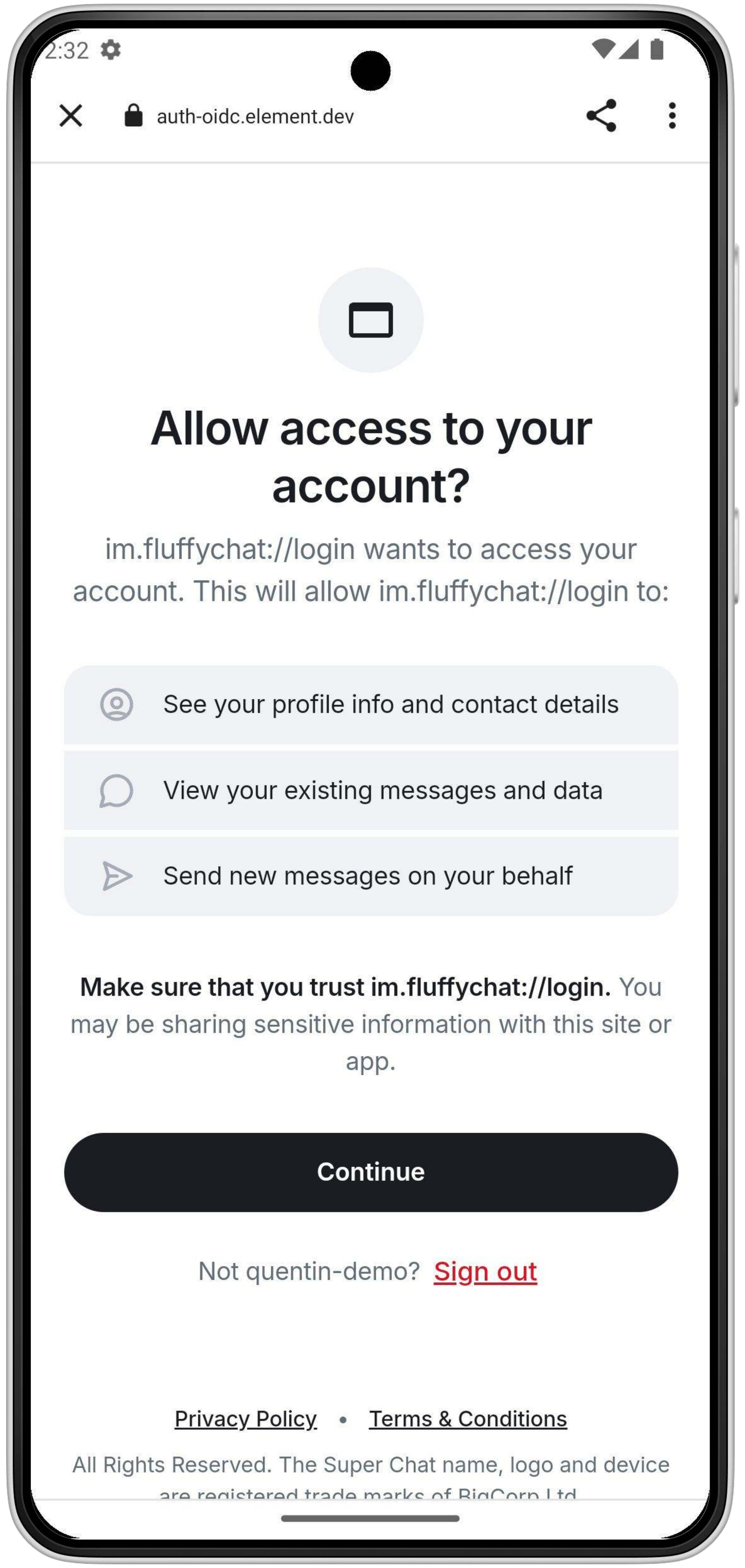
# OAuth 2.0

# m.login.sso

Redirect URI

Access granted



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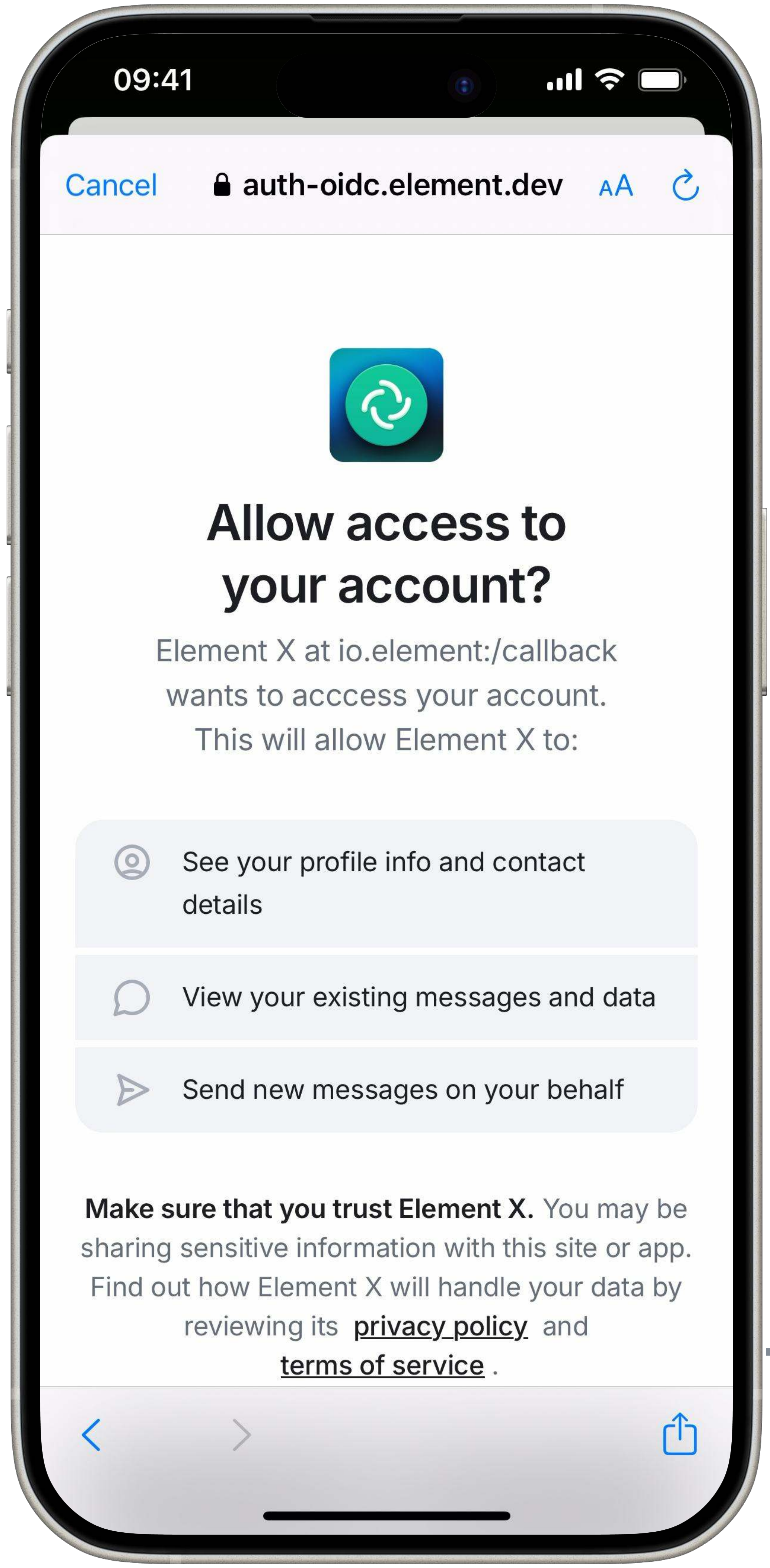

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Logo

Redirect URI

Name

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Privacy policy
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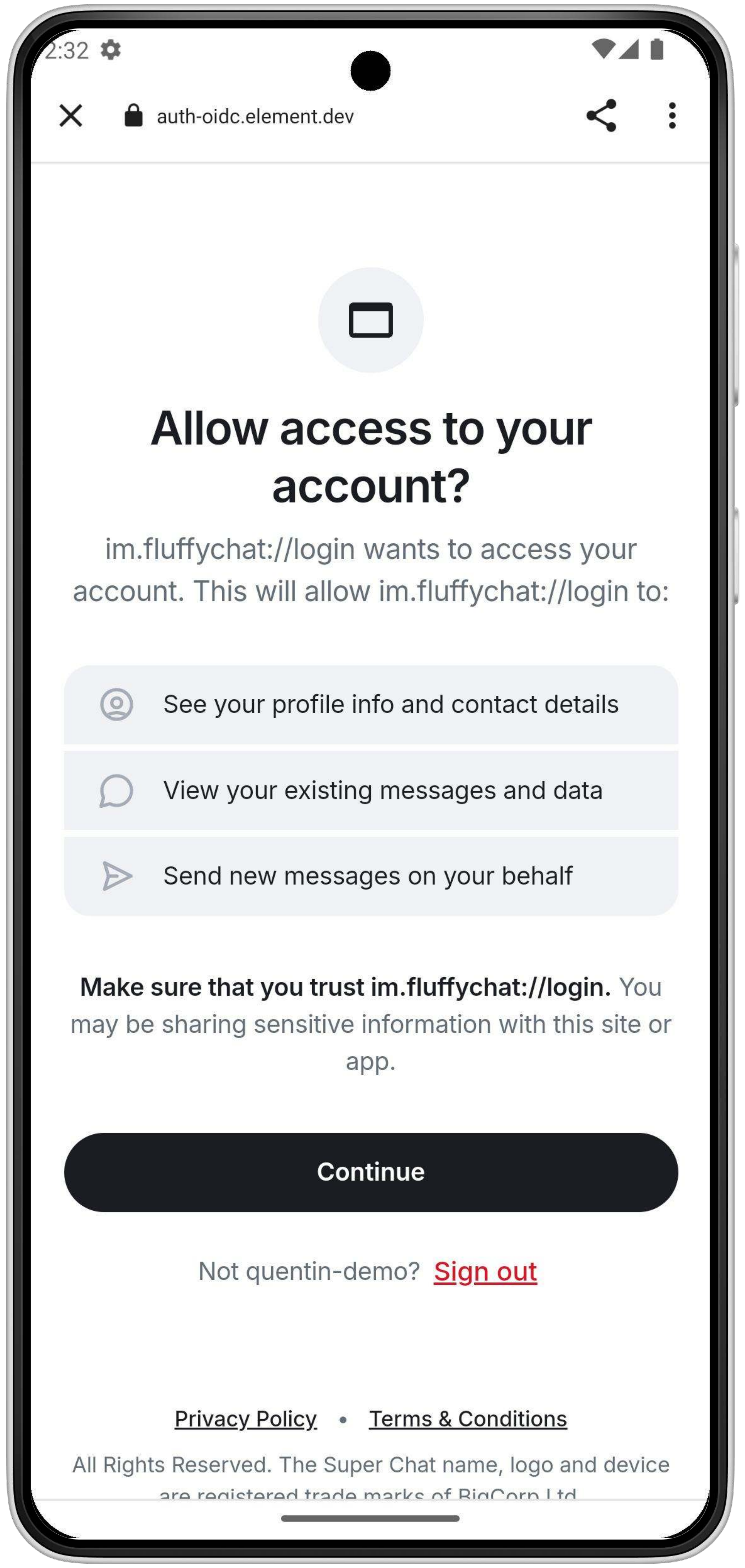

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# Protocol improvements over legacy auth

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## Regarding user-experience

- Rich **client metadata**
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- Rich **client metadata**
- Can return to the client **with an error**
- Can initiate the flow with **different intents**

## Regarding security

- **Strict redirect** URL checks
- Protection against **redirect hijacks**
- **Scoped** access tokens
- **Short-lived** access tokens

# Key takeaways

## What protocol changes we’re proposing

### Authentication through the browser makes the most sense

Many credentials are domain bound & having each authentication step handled by the client doesn’t scale well

### We’re moving Matrix to use an OAuth 2.0/OIDC-based auth system

UIA was a good idea, but too complex in practice.
OAuth 2.0 gives us mature building blocks to replace it.

### Matrix isn’t an account-management and authentication protocol

It currently takes a significant portion of the spec, even though it is not the core of the project

# Key takeaways

## On matrix-authentication-service

### It is a rewrite from the ground-up

In addition to the better, more modern and secure APIs,
we thought of a better user-experience from the beginning

### It replaces part of Synapse

It’s not *‘just’* an OpenID Connect/OAuth 2.0 provider, but
really the rewrite of Synapse’s internal auth system

### We’ll gradually make it easier to run

The long-term goal is to be a part of Synapse, and make the
upgrade as simple as a regular Synapse upgrade

# MSC3861
# Next-generation auth for Matrix, based on OAuth 2.0/OIDC

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## MSC2964 “how to login”

Defines how clients should leverage OAuth 2.0 authorization grant to gain access to the account

## MSC2966 “client tells about itself”

Defines how clients send metadata about themselves, and what we are enforcing

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# Next-generation auth for Matrix

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## “how to login”

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## MSC2966
## “client tells about itself”

Defines how clients send metadata about themselves, and what we are enforcing

## MSC2965
## “discover server params”

Servers have different features and endpoints, this uses OIDC Discovery to discover the “auth server metadata”

## MSC2967
## “base for scoped access”

Opens up the space for scoped access, but only specifies an “access to everything” scope for now

# Support the existing ecosystem

## MSC4911 to link to account-management pages

Account management is getting out of the client, this lets you link to it

## MSC3824 for guidelines for existing clients

Filling some gaps to make sure you can provide a good enough experience

## MSC4190 to make encrypted ASes work without /login

*/login* doesn’t really work for application services and MAS, this fills the gap to work around that

## Features to support other existing use cases

Some features don’t have to be an MSC.
Need an access token for a bot?
MAS should have a feature for that

# What about the future?

### MSC4108 signs you in and sets up E2EE with a QR code

Based on the OAuth 2.0 Device Code Grant
*My boss loves showing off that demo!*

### Client credentials grant for application services

Replace the “hs_token” and “as_token” shared secrets with asymmetric keys

### Widget as Matrix clients

We can now give restricted scopes, what if widgets were just regular Matrix clients?

### Restricted API scopes

We now have the base to give restricted access to a subset of resource

# Can I have it?

An overview of where we’re at, and a rough timeline

# What
# is ready today

- **MAS** support with **Synapse**
- Basic **migration tool**
- Comprehensive **MSCs**
- Solid **documentation**
- **Local password** accounts
- Upstream **OIDC SSO**
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## What
## isn't ready yet

- Community deployment tools
- Community server admin tools
- Encryption for Application Services
- Other homeserver implementations
- ~~Existing clients support~~
  Next-gen auth capable clients

# Get in touch!

**MSC3861** **areweoidcyet.com** **#matrix-auth:matrix.org**

New client
impl. guide!

**github.com/element-hq/matrix-authentication-service**